

# **Avian Comparisons between Kingman and Kenilworth Marshes Final Report 2001-2004**

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## TABLE OF CONTENTS

Cover page.....	1
Contributors.....	2
Table of Contents.....	3
Abstract.....	4
Introduction.....	5
Methods .....	7
Results .....	9
Discussion .....	24
Conclusions .....	27
References .....	29

### List of Maps

1. Aerial photograph of reconstructed Anacostia wetlands .....	31
2. Bird observation areas at Kingman Marsh .....	32
3. Bird observation areas at Kenilworth Marsh .....	33

### List of Tables

1. Total bird list .....	34
2. Total abundances of wetland user species .....	41
3. Additive counts of Canada Goose at Kingman and Kenilworth marshes .....	42
4. Mudflat and shore users .....	43
5. Wetland users observed at Kingman and Kenilworth .....	44
6. Frequencies and abundances of bird species.....	48
7. Breeding bird documentation.....	54

### List of Figures

1. Total abundances by season .....	58
2. Total Canada Goose abundances by season .....	59
3. Canada Goose young abundances by year .....	60
4. Total abundances of birds excluding Canada Goose by season .....	61
5. Seasonal species richness .....	62
6. Winter dominants .....	63
7. Spring dominants .....	64
8. Summer dominants .....	65
9. Fall dominants .....	66
10. User abundances by functional guild and season .....	67

### Appendix 1

Repeated measures ANOVA tables .....	68
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## **ABSTRACT**

In 2001 avi-fauna was added as a parameter to be monitored as an indicator of the status and relative success of the two reconstructed freshwater tidal wetlands residing in the Anacostia River estuary in Washington, D.C. at that time. They were Kenilworth Marsh which was reconstructed in 1993 and Kingman Marsh seven years later in 2000. Other studies were already underway looking at vegetation, seeds, soils and contaminants. Even though these new wetlands were relatively small, together about 70 acres, it was felt this might be sufficient areato sustain and attract birds to the habitat. Birds have been used elsewhere as wetland indicators and we hoped they could prove useful here especially in terms of numbers and species richness. The study was conducted for almost four years (2001-2004) and was designed to ascertain if the recently reconstructed Kingman Marsh evolved similarly with respect to the avi fauna as Kenilworth which had the seven year head start. Twelve observation points were established, six at each marsh, which were to be used weekly so as to alternate the high and low tidal regimes and the observation start times. Additional notations were recorded for species while walking between observation points. The course of the study became interrupted with the incursion of resident Canada geese particularly upon the Kingman Marsh site. Goose herbivory coupled with lowered sediment elevations reduced vegetation cover at Kingman Marsh to less than one-third its intended scope while Kenilworth was barely affected. The result was actually much less impact on the bird populations than on the vegetation. In fact the additional mudflat area at Kingman may have actually helped attract some birds. Together 177 species were identified at the marshes comprising 14 taxonomic orders and 16 families, 137 species at Kingman and 164 at Kenilworth. However, Kingman actually attracted more birds than Kenilworth, whether or not Canada Geese were included. At both wetlands winter usage was significantly greater than at other seasons; however, there were more species in the spring and summer. Three functional guilds were looked at in particular: wetland users, freshwater marsh users and mudflat/shore users. Mudflat users were greatest during the winter while marsh users were greater in the fall. Additional useful data was collected relative to the Canada Goose impacts. The interruption in marsh evolution at Kingman driven by the goose herbivory precluded the opportunity to use the avifauna as an indicator of marsh restoration success.

## INTRODUCTION:

This study was conducted to use avian populations to track the health and progress of the reconstructed Kingman Marsh as was also being done with such other indicators as vegetation, benthos, seed bank, soil and sediment processes. Birds, especially those most dependent on marsh habitat, have been used as indicators for degree of wetland restoration success for other projects (Weller 1978, Odum et al. 1984, Mitsch et al. 1998, Mitsch and Gosselink 2000, Havens et al. 2002).

As part of the effort to improve the aesthetics, water quality and habitat of the urbanized Anacostia watershed in Washington, D.C., the U.S. Army Corps of Engineers (COE) in concert with the District of Columbia (D.C.) are reconstructing several wetlands (**Map 1**). Such freshwater tidal marshes process pollution while providing habitat, food and nesting areas for a variety of wildlife. Two such wetlands are Kenilworth Marsh (32 acres), which was reconstructed in 1993 and Kingman Marsh (35 acres), which was just reconstructed in 2000, seven years after Kenilworth. Kenilworth Marsh surrounds Kenilworth Aquatic Gardens, a National Park Service (NPS) cultural site comprised of 44 horticulturally oriented aquatic ponds, while the marsh itself is partially bounded by riparian forest as well as elevated ballfields and a small meadow on an old landfill. Kingman Marsh Area 1, which was the unit studied, is about a half mile downstream from Kenilworth but off the west bank and is surrounded by the 18-hole Langston Golf Course along with narrow strips of riparian forest (Kingman Marsh Area 2, which was not part of this study but has been included in other related non-avian studies, has RFK Stadium on one side and Heritage Island on the other ) ( **Map 1**). These tidal marshes experience on average a 3 foot tidal exchange twice daily such that portions of marsh area too low to support vegetation (below 1.5' NGVD '29 = the mean tidal elevations for a period of years around 1929) become exposed mudflat at low tide which attracts shorebirds. At low tide roughly one third of the area remains open water, one third is mudflat and one third emergent vegetation. At Kingman Marsh where herbivory is intense, likely a consequence of the golf course attracting populations of resident Canada Goose, there is less than a third of the area that would normally be vegetated so the mudflat component is increased there. At high tide there would be little or no mudflat. Both marshes are low energy in that they lie behind island/berm structures which protect them from the energies of the main Anacostia channel. While no two sites in this world will be identical, the hypothesis has been that Kingman and Kenilworth are close enough with respect to important features that there is ample reason to compare one with the other and expect in time the bird populations should be alike. While both wetlands were undergoing succession during the course of the study, data from vegetation studies suggests that succession rates had slowed close to stability at Kenilworth except for influences from invasive non-native species. The point is that it would be reasonable to expect relatively rapid succession rates under normal conditions at the recently reconstructed Kingman Marsh allowing it to converge over time with Kenilworth Marsh. It was hoped that this study would be able to help document that rate of convergence using the avi-fauna as an indicator. To emphasize (refer to **Map 1** which is actually a photograph of the study area), both wetlands were reconstructed in the same way with the same dredge material source, they are of similar size and lie about one half mile apart along the Anacostia behind protective berms but remain freshwater tidal systems,

Kingman is surrounded by a golf course while Kenilworth is bounded on two sides by a recreation area on what previously had been a landfill, both are partially bounded by strips of riparian forest (though the riparian forest tends to be older and denser at Kenilworth) and both are located in an urban setting experiencing regular human interactions. The urban character of the Anacostia is important in understanding the way birds may use the area. Being located within the city of Washington, D.C. these wetlands are but small pockets of wildland surrounded by city life. They are heavily influenced by pollution (the Anacostia is one of the three most polluted watersheds in the Chesapeake Bay) and are continually exposed to human visitor presence. The urban influences affect both sites and the birds that use the Anacostia estuary. Consequently, there will be a relatively large component of birds (such as the Ring-billed Gulls, resident Canada Goose, Crows, Mallards, etc.) adapted to this disturbed area that wouldn't be found in more natural locations. In this context it is still impressive just how much the Anacostia is used, almost as a refuge by many avian species. Also, part of the challenge of improving the Anacostia will involve pollution reduction and habitat improvement. Once again, the avi-fauna may prove useful in documenting overall progress in the lower Anacostia, one aspect of which would be a reduction in prevalence of disturbed area birds.

Bird monitoring was conducted from 2001 through 2004 at both Kingman Marsh and Kenilworth Marsh. These two reconstructed wetlands lie about half a mile apart on opposite sides of the Anacostia estuary (**Map 1**). Comparisons were made *within* each site to detect changes over time as well as *between* sites to determine whether the difference in time phase displayed itself in the avian populations. The hypothesis was that by November 2004 (the planned end of the five-year vegetation and soils study), the two sites would have converged in terms of bird species abundances and richness as the vegetation community at Kingman Marsh evolved to become more similar to that of Kenilworth Marsh, established seven years earlier.

Although the avian study was originally envisioned and approved as a five-year project, it was decided to terminate the field portion of the study in 2004, at the same time as the completion of the five-year vegetation, seed bank and soil study. If constraints of budget and personnel availability permit, the authors believe that additional valuable information could still be gleaned from the marshes in future years, especially since grazing and erosion has thwarted marsh development at Kingman thus far. If the vegetation were to recover from these pressures, improved habitat should attract more birds and such an occurrence should be documented.

This final bird report presents the results for the entire four-year bird study, conducted from 2001 through 2004, and represents the bird component of a larger five-year report that also includes segments on vegetation, benthos, and sedimentation elevation tables for the Kingman Marsh Restoration Project. Previous annual bird reports can be found on the USGS Patuxent Wildlife Research Center's website (<http://pwrc.usgs.gov> - Our Research/ Wetland Communities/ Anacostia...) as part of the inclusive Annual Report for each year or they may be obtained by contacting Dr. Dick Hammerschlag, USGS Patuxent Wildlife Research Center, Beltsville Lab, Maryland 20705; [rdhammerschlag@usgs.gov](mailto:rdhammerschlag@usgs.gov)). The Final Report concerning vegetation, seed and soils: "Five years of Monitoring Reconstructed Freshwater Tidal Wetlands in the Urban Anacostia River (2000-2004)" should also be available as above (Hammerschlag et al., 2006).

## METHODS:

The study was designed to use a comparable series of observation points and associated walk-throughs between the points strung along a portion of the marsh perimeters of both Kingman Marsh and the seven year older Kenilworth Marsh. The collected data has been used in two ways. Total counts based on observations from the five-minute point counts and the walk throughs between the points have been used to document presence, relative abundance and richness overall and for habitat types as presented under **Field Observations** or **Descriptive** headings. Much of this data is presented in the Tables and includes sightings from both the point counts and the walk-betweenes. On the other hand, **Statistical** approaches based only on the five minute point counts (not sums of total observations or data from walk throughs), use Repeated Measures Analyses to document and verify comparisons and trends among bird components that are not independent. Much of this data is presented as Figures. The study commenced November 2000 and continued thereafter at yearly intervals (December – November) through November 2004.

### Field Observations

Bird observations were conducted weekly throughout the four study years, to capture birds using the marsh areas at both the high and low tides of the two-week tidal cycle. It was felt that if the 3-foot tides were not stratified in the study, observations might be skewed by chance tide levels. For example, one would expect to observe more shore birds at low tide. The starting site for monitoring was also alternated weekly to avoid bias for time of day (since it could take as much as two hours to complete one marsh before getting to the other).

Timed 5-minute point counts were conducted weekly at 12 permanent observation points (six at each marsh). Observations were based on sightings from the same spot each time looking into the wetlands with a view span of approximately 180° and/or calls coming from that view span. This focus meant that most of the observations should be of avian species associated with the wetlands. The number of birds observed per species was recorded for each point count, as well as for the walk-throughs between points.

Six of the permanent observation points were established at Kingman Marsh Area 1 (**Map 1** and **Map 2**). These points represented a range of habitat types. Initially they consisted of one open water area (Point # 1), three wetland edge/open water or mudflat areas (Point #s 2, 5, and 6) depending on the height of the tide, and two primarily wetland areas (Point #s 3 and 4). This characterization changed over time, however, as the vegetation at Kingman declined dramatically, starting in 2001, presumably as the result of herbivory by resident Canada Goose (*Brant canadensis maxima* race mostly but possibly also *B. c. moffitti* during the summer; during the winter the mixed race population could also include *B. c. interior* and *canadensis* – Hindman et al., 2004). Determination of the race structure of resident Canada Goose (Atlantic Flyway Resident Population) in the Anacostia has not been made. The walk-through areas were not used in the statistical analysis but did provide data for the over-all numbers such as represented in the Tables, are also labeled on the map (walk-through areas A through F).

Kenilworth Marsh was also monitored with six 5-minute point counts (**Map 1** and **Map 3**) which included one open water area (Point # 6), two wetland edge/open water or mudflat areas (Point #s 2 and 3) and three mostly wetland areas (Points #s 1, 4, and 5). Walk-through reaches between observation points or areas used for un-timed observations are also labeled (A through F).

### **Data Analyses**

Data from both the point counts and the walk-throughs were used for descriptive purposes to create species lists and overall species abundances and frequencies.

Repeated measures analysis of variance was used to determine whether the birds observed at Kingman and Kenilworth marshes during the five-minute point counts from winter 2001 through fall 2004 differed significantly over time in terms of seasonal abundances for the following: all birds combined, Canada Goose, Canada Goose young, seasonally dominant species, and wetland users.

Canada Goose young data were analyzed by year for the period starting with the fourth week in April and ending with the fifth week in June, since this was the time frame during which Canada Goose young of the year were distinguishable from adults.

Seasonal dominants were defined as species with a seasonal average of at least 1.0 bird observed per five-minute point count during at least one year of the study.

The identities of the birds observed during the course of the study were used in conjunction with recognized habitat classifications provided in Iliff, et al (1996) to establish a functional group of wetland users consisting of avian species known to use the various wetland habitat types associated with our sites (e.g., fresh marshes, tidal mudflats, bottomland forests, rivers, and estuaries). A smaller subset of the wetland users group consisting of known users of freshwater marsh habitats (Iliff, et al, 1996) was also identified and analyzed separately. This sorting was done with the intent of sharpening the focus of avian populations to those most likely dependent on the reconstructed marshes. Since the wetlands are relatively small (various individual sections being close to 30 acres), there has been the concern that a portion of the birds observed may be in the marsh area purely by proximity or chance as opposed to being drawn there primarily by the marsh habitat. Avian abundances were documented as abundant, common, uncommon or rare in Table 1 since these classes should be sufficient to document the relative prevalence of the bird species observed. The Canada Goose abundance data was excluded from all three data sets for the statistical analyses, since Canada Goose was already analyzed separately, and its large abundances would probably mask any effect of the other wetland and marsh users. A group of mudflat/shore habitat users was also teased out of the wetland numbers, to determine whether the relatively large amount of unvegetated habitat created at Kingman presumably by goose herbivory corresponds with a larger number of users of this type of habitat than are found at Kenilworth, which has less unvegetated area.

Species richness was also analyzed using repeated measures analysis.

Tukey tests were used to determine the statistical significance of pairwise comparisons. Means expressed below are least square means  $\pm$  1 SE.

## RESULTS:

### Descriptive

The following is a summary (non-statistical) of all of the birds observed in the marsh and surrounding areas involving the timed point counts as well as the species observed between the point counts. Although some bird species are not wetland dependent, the wetland still can serve to benefit them by providing food and water. As a corollary, wetland species may be attracted by areas surrounding the wetland. **Table 1** shows the compilations of relative abundance of all species observed during each of the four study years at the two study sites represented as four relative abundance rankings which are defined in the Table legend. There were a total of 177 species seen at both sites combined in all four years. Kenilworth had a total of 164 species and Kingman 137 species. There were 124 species common to both sites. Four species of birds occurred prior to the completion of the reconstruction of Kingman Marsh but not since. There were forty species unique to Kenilworth and thirteen species exclusive to Kingman. An example of the frequency of observations of birds by species for each site at each season is provided in **Table 6** based on data collected in 2003.

### **Marsh Species**

Thirty-eight fresh marsh species occurred at both sites (**Table 2**). Fresh marsh species were determined from the habitat codes as listed in the Field List of the Birds of Maryland (Iliff, et al, 1996). Of these 14 occurred at both sites in about equal numbers. Fifteen occurred at Kenilworth more frequently and/or in greater numbers than Kingman. Of those, seven were observed exclusively at Kenilworth. New to the list in Year Four were Sora calling in Kenilworth Marsh in the area accessed by the new extension to the boardwalk. They were heard on one occasion during the fall migration. Nine freshwater marsh species occurred more frequently or in greater numbers at Kingman. Only two of these species were exclusive to Kingman. One of the successes of Kingman has been the nesting Marsh Wren for three of four years. In 2004 at least three pairs could be heard during the breeding season. A Marsh Wren first nested at Kenilworth in 2001 in the small marsh at the end of the boardwalk. Perhaps this bird relocated to Kingman. It was heard a few times at the beginning of the breeding season at Kenilworth in 2004 but not during the “safe dates” as a potential breeder. Also of interest is the great abundance and frequency of Common Yellowthroat at Kenilworth.

There were many more Canada Geese observed at Kingman and on more occasions. The population is maintaining itself at Kingman whereas they have declined at Kenilworth since 2001 (**Table 3**). The elevated population of Canada Geese at Kingman continues to set back the efforts of the marsh restoration due to overgrazing the vegetation particularly in the spring when the goslings feed voraciously and the female adults need to restore their energy reserves from nesting. An attempt to at least temporarily revive portions of the marsh includes the installation of perimeter fencing and replanting with plants less palatable for the geese. Canada Geese are a species of special interest and concern to the successful development of the reconstructed wetlands and have been addressed in greater detail in a separate section of the report.

Double-crested Cormorants were more frequent and abundant at Kingman than Kenilworth in all years. Both sites were equal in species richness for the birds in the order Ciconiiformes (Herons, Ibis, and Vultures). Kingman hosted greater abundance for all birds in this order in all years.

There were 16 species of the order Anseriformes (geese and ducks) observed between the two sites (**Table 1**). The two sites were equal in species richness. Wood Duck and American Black Duck were more frequent and abundant at Kenilworth in all four years. In all years Canada Geese were more abundant at Kingman than at Kenilworth (**Table 3**). Mallard and Common Merganser numbers were relatively equal between the two sites.

Ten species of birds from the order Falconiformes (Hawks and falcons) were observed equally at the two sites. Kenilworth maintained greater abundance of raptors in all years. Red-shoulder Hawks and Ospreys were the top two raptors in abundance. Bald Eagles were about equal in numbers at both sites. Frequency between the two sites was about equal.

### **Mudflat/Shorebird Species**

There were twenty-three species from the order Charadiiformes (shorebirds, gulls, and terns) observed between the two sites. More specifically, **Table 4** shows the mudflat users (17 species as given in Illif et al. (1996) or personal observations)) and sites where they occurred more abundantly. Kingman had greater species richness of this group and hosted a greater abundance in all years. This showing is consistent with the increase in mudflats (actually areas unvegetated) at Kingman as a result of the goose grazing. The most abundant species of shorebirds were Killdeer, Greater Yellowlegs, Semi-palmated Sandpipers, and Least Sandpipers. Greater Yellowlegs and Semipalmated Sandpipers were more abundant and frequent at Kingman. Killdeer and Spotted Sandpipers were about equal in frequency and abundance between the two sites. Solitary Sandpipers were more abundant at Kingman with equal frequency between the two sites.

### **Wetland and Associated Site Users**

Chimney Swifts were more abundant at Kenilworth. Belted Kingfishers were more frequent and abundant at Kenilworth in all years.

The top two flycatcher species were Eastern Phoebe and Eastern Kingbird that nested at both sites. These birds primarily occur in wood margins, hedgerows, and scrub. Eastern Phoebe was observed and counted more frequently at Kenilworth.

Crows were more abundant at Kingman. Species richness of swallows was equal at both sites but Kingman had greater number of total birds. Kenilworth hosted greater abundance of Carolina Wren and Winter Wren.

Kinglets and Blue-gray Gnatcatchers were more abundant and frequent at Kenilworth. Golden-crowned Kinglets were observed solely at Kenilworth. Six of the seven species of thrushes that occur in D.C. were observed between the two sites. Kenilworth had greater relative species richness but Kingman had greater abundance. The top thrush species in abundance was American Robin.

Twenty-four species of warblers occurred between the two sites. Kingman had nine species of warblers whereas Kenilworth hosted all 24 species encountered (likely attracted by the more extensive forested area). Eleven species of sparrows were seen between the two sites. Song

Sparrows occur about equally between the two sites. Swamp Sparrows are more abundant at Kenilworth.

Of the mimids, only Northern Mockingbird were more abundant with about equal frequency at Kingman. Many fledglings are observed in the summer along the golf course. Both sites had all three mimid species that occur in D.C. European Starlings were again quite numerous at Kingman. They occurred more frequently at Kingman and in greater abundance. Cedar Waxwings were more abundant at Kingman with about equal number of occurrences.

### **Breeding birds**

There were 57 species of breeding birds at Kingman and 56 at Kenilworth in and around the marshes. There were 46 species common to both. There were 11 nesting species unique to Kingman and 10 exclusive to Kenilworth. It would be worthwhile for the purposes of this study to link breeding birds to habitat, especially the reconstructed wetlands. **Table 5** does provide the habitat that the sighted birds typically use. As an example of the type of linkages that may be drawn, data collected in 2003 was associated with standard breeding bird criteria found in the Second Maryland/DC Breeding Bird Atlas for 2002-2006 as produced by the Maryland Ornithological Society (**Table 7**). Frequent breeding birds would include Red winged Blackbirds, Marsh Wrens, Common Yellow Throat and Swamp Sparrow. It would be desirable for marsh structure in the Anacostia to reach the point where occasional breeders such as American Bitterns or possibly even some Virginia Rails would return.

### **Canada Geese**

Kingman may not have been an ideal place for the wetland restoration in light of the elevated population of Canada Goose that had been settled there for a number of years. The area had been a tidal lake for over 60 years with the lush vegetation of the golf course surrounding it. This combination provided attractive and optimal habitat for the geese, although the golf course itself was the primary cause for the major concentration of Canada Goose at or around Kingman Marsh. Also, the small islands within the lake provided some protection from predators and a suitable nesting habitat. In hindsight, if the habitat and environment had been assessed with regard to the immediate Canada Goose population prior to planning for the wetland restoration, one should have observed the large number of geese and imagined their potential impact on a newly planted marsh. However, Kenilworth had been exposed to a similar situation when it was planted just seven years prior in 1993 but it did manage to outgrow most goose herbivory impacts. Only some edge and isolated wetland pockets were impacted by goose grazing at Kenilworth. A somewhat lower goose population resided there and perhaps a more suitable sediment elevation was a real factor in the ability of the marsh to outgrow the herbivory pressure. Regardless of marsh survival at Kenilworth, herbivory by over abundant resident Canada Goose has been documented as a primary factor in the demise of much of the reconstructed Kingman Marsh (Hammerschlag et al. 2006).

Canada Goose in the Anacostia is comprised of two populations depending on the time of the year. In the early fall (late September-early October) migratory Canada geese join the year-round present resident Canada Goose (rCg) for the winter season before migrating north by the end of winter (mid-March) to breed. The goose population essentially doubles during the Fall-Winter season (**Table 3**) with the influx of migratory Canada geese.

Resident Canada Goose (mostly *Branta canadensis maxima* but also *B.c. moffitti*), one of four subgroups subgroup of Canada Goose also known as the Atlantic Flyway Resident Population - AFRP (Hindman 2003), consists of large birds frequently 12-14 lbs or more that have adjusted well to a year-round resident status. This population has been postulated to have been derived from Canada geese that were captive bred in the mid-West and introduced east of the Appalachians (Hindman 2003). They have adapted so well to urbanized areas that in some cases may actually become tame, over-abundant and a nuisance. Such seems to be the case in the Anacostia (Harris, 2002). These geese often attain an age of 20 years. In the Atlantic Flyway the rCg population increases 6-14% annually (USFWS DEIS, 2003). For the Anacostia our data suggest population increase for all geese from 2001 to 2002 but a decline for the 2003 and 2004 years (**Table 3**). It is important to keep in mind that these counts are generated from observations covering but a small portion of the Anacostia habitat. Thus the absolute numbers are not as important as the relative counts to each other. It was also observed that rCg tended to feed in large groups such that counts could be quite patchy – if a group was within the observation area counts would be high, otherwise very low if any at all. By conducting surveys weekly it was hoped that some of these variations in counts would tend to even out.

In contrast to the migratory Canada goose, the resident Canada Goose may become larger weighing closer to 13 pounds. Thus the resident geese exert that much more grazing pressure due to their increased appetite, grazing pressure during the growing season when the wetlands are growing (and not normally impacted by geese), feeding voracity of female adults especially when preparing for broods, the rapidly growing brood goslings, and simply by maintaining pressure on the wetlands at all times of the year whether nipping seedlings, grazing growing plants or eating propagules and roots.

Management of resident Canada Goose populations is challenging and often entails a combination of actions. There do not seem to be any significant natural checks and balances in play in the Anacostia wetlands such as predators (including feral dogs), disease, or food and habitat limitations. There is some predator pressure on eggs and goslings, but little on the mature birds. As a result local populations of rCg have been increasing, becoming over abundant and frequently being a nuisance. Real damage results through their herbivory which has led to Kingman Marsh being reduced to less than one third its original cover along with severe reduction in palatable plant species. Ultimately it will be necessary to achieve an ecological balance between resident Canada Goose populations and the ability of established wetlands to sustain themselves.

Reproducing resident Canada Goose have established elevated populations (currently estimated to be about 600 birds in the Anacostia estuary as a result of the 2004 -2005 census conducted three times annually when only rCg were present) most of which may be found proximal to wetland areas of concern. The geese have been observed and documented causing extensive damage by grazing wetland plants in the reconstructed Anacostia wetlands, while otherwise being a nuisance in the immediate region through feces deposition and other population pressures.

Efforts to manage the rCg population are currently focused on producing a Goose Management Plan/Environmental Assessment (EA) by the US Department of Agriculture Wildlife Services for the NPS and D.C. In the interim a separate EA has been approved which supports egg oiling as a means to keep the population of rCg from increasing. Egg oiling was first conducted in 2004 and continues to be done.

### **Statistical**

The following results are based on the repeated measures analysis of variance and Tukey tests. We used Tukey tests to compare results from two related parameters and determine whether they are significantly different from each other. Pairwise comparisons were made using Tukey's Studentized Range Test of Least Squares Means (family-wise error rate with  $\alpha = 0.05$ ). The ANOVA tables themselves are provided in **Appendix 1**.

#### **Total bird (all birds) abundances**

Analysis of the bird data revealed that significantly more birds have been observed at Kingman than at Kenilworth (overall averages of  $45.9 \pm 6.2$  and  $23.5 \pm 6.5$  birds observed per five-minute point count at Kingman and Kenilworth, respectively; **Fig. 1**). From the seasonal standpoint (This means comparing *vertically* each pair, e.g., winter-01 at Kenilworth to winter-01 at Kingman.) only the winter seasons of 2001 and 2003 (notice different lower case letters) saw statistically significant differences in total bird abundances between Kingman and Kenilworth (averaging  $72.4 \pm 7.0$  and  $29.2 \pm 6.9$ , respectively). Points without letters are not significantly different.

Total bird abundances were typically higher at Kingman than at Kenilworth, although differences within a sampling period were only significant in the winters of 2001 and 2003 (lower case letters), representing only two of the sixteen seasonal sampling periods monitored during the course of the four-year study.

As illustrated in **Figure 1**, Kingman exhibited some year to year differences (This means looking *across* the figure to get differences from one year to another; labeled with capital letters; significant differences occur where the capital letters differ), with significantly higher total abundances observed in the summer of 2002 (an average of  $58 \pm 8$  birds observed per five-minute point count), than in the summers of 2003 ( $26 \pm 8$ ) or 2004 ( $30 \pm 8$ ). Total abundances at Kenilworth, on the other hand, remained stable over time, with no significant year to year differences (average of  $21 \pm 8$  birds per five-minute point count in the summer of 2002).

#### **Canada Goose abundances**

Canada Goose was the first group teased out of the total bird abundance numbers, since, given the extensive goose herbivory experienced at Kingman, we wanted to know whether significantly greater numbers of Canada Goose were being observed at Kingman than at Kenilworth. The analysis revealed that greater numbers of Canada Goose have been observed at Kingman than at Kenilworth, especially during the winter season ( $p = 0.0064$ ), when Kingman averaged  $39.0 \pm 5.9$  birds observed per five-minute point count compared to Kenilworth's  $8.6 \pm 5.8$  (**Fig. 2**). This indicates that observation of all the data but disregard year, significantly more birds were observed during the winter seasons at Kingman than at Kenilworth. If the sample size

were decreased within the sampling unit by looking at individual seasons within individual years, only one of the 16 seasonal sampling periods showed significant differences between Kingman and Kenilworth. That was the winter of 2003, when Kingman averaged  $58.7 \pm 10.1$  Canada geese observed per five-minute point count and Kenilworth averaged only  $6.8 \pm 8.6$ . Canada Goose also averaged significantly greater numbers at Kingman than at Kenilworth when averaged across year and season ( $24.8 \pm 5.3$  compared to  $7.0 \pm 5.5$ ). Neither site exhibited any significant seasonal year to year differences, but overall, Kingman did show a decline from 2002 to 2004 (averaging  $30.0 \pm 5.5$  and  $20.3 \pm 5.6$ , respectively).

It should be noted that the winter populations, which include the migratory Canada Goose, are less important to marsh grazing impacts than the resident goose populations present during the spring and summer growing seasons.

In a separate effort from this study, Canada goose 5 minute census counts were conducted in the Anacostia from Bladensburg, Maryland to Poplar Point (the tidal reach of the Anacostia) relying on teams of volunteers organized by the Anacostia Watershed Society to cover this reach essentially simultaneously to avoid double counting. The results from April, 2004 thru December, 2005 are **2004**: April 10 = 587, July 17 = 694 and September 11 = 327; and **2005**: April 13 = 539, July 13 = 671, August 31 = 650 and December 2 = 1221. This data indicates about 600 resident Canada geese and twice that many geese once the migratory geese arrive along the Anacostia estuary in the early fall. About a third of these geese frequent the Kingman Marsh area and another quarter the Kenilworth Marsh area (the majority of which use the ballfields).

#### **Abundances of Canada Goose goslings**

Canada Goose numbers were further teased apart in an attempt to gauge whether the egg-oiling operations begun in the spring of 2004 might be impacting abundances of Canada Goose young. Although the graph of the annual means suggests that there has been a decrease in numbers of Canada Goose young observed at Kingman over the course of the study (**Fig. 3**), it does not appear attributable to the egg-oiling, since the apparent decline began in 2002 and egg-oiling impacts would not have been felt until 2004. From the statistical standpoint, none of the observed changes were significant, although the year\*area interaction came closest to statistical significance (with a p value of 0.0746), suggesting that there might be some merit behind the idea that the sites have behaved differently over time with respect to numbers of Canada Goose young observed per five-minute point count. It should be noted that the statistical significance of any differences observed would probably be masked by the large variability reflected in the magnitude of the error bars associated with these data. Since the locations where goslings are observed may be patchy, it might be better to try to conduct a census count rather than rely on point counts.

#### **Abundances for all birds except Canada Goose**

The second subgroup we looked at was the total for all birds except Canada Goose (**Fig.4**). Analysis revealed that significantly more birds (excluding Canada Goose) have been observed at Kingman than at Kenilworth. From the seasonal standpoint, only the winter season showed significant differences between Kingman and Kenilworth, which averaged  $34.4 \pm 2.7$  and  $18.6 \pm$

2.9, respectively. The significance of the seasonal differences also depended on year, with significant differences within any one sampling period limited to the winter of 2001, when Kingman averaged  $55 \pm 4$  birds per five minute point count (due mostly to large numbers of Ring-billed Gull) and Kenilworth averaged only  $14 \pm 4$ .

### **Species Richness**

As might be expected due to migration sightings, species richness (averaged across sites) was significantly greater during the spring ( $5.9 \pm 0.3$  species observed per five-minute point count) and summer ( $6.3 \pm 0.3$ ) seasons than during the fall ( $4.6 \pm 0.3$ ) and winter ( $4.8 \pm 0.3$ ) seasons. No significant differences were observed between Kingman and Kenilworth either between seasons, or within any of the sixteen seasonal sampling periods monitored during this study (**Fig.5**). Both sites showed some year to year differences, with species richness at Kingman averaging significantly higher in the summer of 2002 (an average of  $8.31 \pm 0.42$  bird species observed per five-minute point count) than in any of the other summers. In addition, the species richness average at Kingman in the spring of 2002 ( $6.64 \pm 0.42$  bird species) was significantly greater than in the spring of 2004 ( $4.63 \pm 0.44$ ). Kenilworth also exhibited a peak in the species richness in the summer of 2002 (averaging  $7.98 \pm 0.47$ ) significantly greater than all the other summers (for example, an average of  $5.51 \pm 0.50$  in the summer of 2004).

### **Sørensen's Similarity Index**

Similarity of species composition at the two areas was determined using Sørensen's Similarity Index . Sørensen's Similarity Index compares presence/absence data from two areas to produce an index that varies from 0 if the areas have no species in common, to 1 if both areas have all species in common. Results indicate that the index is similar between the two sites for 2001 (.76), 2003 (.74) and 2004 (.75). The highest Sørensen's Similarity Index was in 2002 (.81).

### **Seasonal Dominants**

Data on seasonal dominants (taxa averaging at least 1 bird observed per five-minute point count in one season of one year) are presented in three ways: graphically by season and site (**Figures 6 through 9**), textually by season, and textually by taxon. Repeated measures analysis was done only on the species that made the dominant species cut as defined above. A list of all species observed at the two sites during the course of the four-year study can be found in **Table 1**. Migratory birds spending little time in the wetland area are asterisked. Each bird species has its own characteristics and usage pattern in the wetland area – some using the wetland more intensely than others. Based on the methods used in this study we could not refine the manner each species interacted with the wetland habitat. Thus the birds are grouped somewhat arbitrarily according to season as a way to categorize the pattern of marsh usage. A more detailed study would be needed to follow each species and linkage to habitat during its period of using the wetland area.

### **Seasonal Dominants by Season**

#### **Winter**

Of the eleven species (or taxa) that averaged  $\geq 1.0$  bird observed per five-minute point count in any of the four winters at either Kingman and/or Kenilworth, and were therefore treated as winter dominants, seven were common to both sites (**Fig. 6**). These species consisted of Canada

Goose, Ring-billed Gull, Crow sp., Mallard, American Crow, Fish Crow and European Starling. Of these, all but European Starling were present during the winter at abundances significantly greater than during any of the other seasons. Winter averages (over both sites and all four years) for these seven species were  $23.8 \pm 4.2$  birds observed per five-minute point count for Canada Goose,  $11.5 \pm 1.1$  for Ring-billed Gull,  $4.7 \pm 0.6$  for Crow sp.,  $2.8 \pm 0.5$  for Mallard,  $1.6 \pm 0.2$  for American Crow,  $1.4 \pm 0.2$  for Fish Crow, and  $0.5 \pm 0.6$  for European Starling.

Canada Goose numbers averaged significantly greater at Kingman than at Kenilworth, during the winter season ( $39.0 \pm 6.0$  compared to  $8.6 \pm 5.8$ ) and across years and seasons ( $24.8 \pm 5.3$  compared to  $7.0 \pm 5.5$ ). This finding is in keeping with the significantly greater herbivory damage sustained at Kingman and attributed to Canada Goose. Looking within the individual sampling periods, Canada Goose numbers were significantly greater at Kingman than at Kenilworth for the winters of 2003 and 2004.

Ring-billed Gull and Fish Crow also averaged significantly greater numbers at Kingman than at Kenilworth when averaged across all four winter seasons, with  $16.2 \pm 1.5$  Ring-billed Gull observed during the average winter five-minute point count for Kingman compared to  $6.9 \pm 1.5$  for Kenilworth, and  $1.0 \pm 0.1$  Fish Crow at Kingman compared to  $0.5 \pm 0.2$  for Kenilworth.

For Crow sp. significance of differences between Kingman and Kenilworth was limited to the winter of 2001, when significantly more Crow sp. were observed at Kingman ( $12.7 \pm 1.2$ ) than at Kenilworth ( $1.2 \pm 1.2$ ).

None of the biologically significant pairwise comparisons between Kingman and Kenilworth proved statistically significant for either Mallard or American Crow.

Two species sorted out as winter dominants at Kingman, but not at Kenilworth. Great Blue Heron averaged  $0.7 \pm 0.2$  for winters at Kingman, compared to  $0.1 \pm 0.2$  for Kenilworth. This was not statistically significant, although other seasonal differences were significant for Great Blue Heron (see Fall). The statistical significance of the Season\*Site interaction term for Great Black-Backed Gull ( $p = 1.16E-14$ ) indicates that the sites behaved differently with respect to the seasons, with Kingman exhibiting a seasonal pattern peaking in the winter ( $0.5 \pm 0.7$ ) and Kenilworth's numbers remaining flat across the seasons (averaging  $0.8 \pm 0.5$  overall).

Red-winged Blackbird (an important marsh species) and Common Grackle sorted out as winter dominants at Kenilworth, but not at Kingman. Averaging across all four winters, the overall winter average for Red-winged Blackbird at Kenilworth was  $0.7 \pm 0.6$ , compared to  $0.2 \pm 0.6$  at Kingman. This difference was not statistically significant, although there were other statistically significant seasonal differences between the two sites (see Fall). Common Grackle appeared as a blip on the radar screen in the winter of 2004 at Kenilworth, when its average of  $1.1 \pm 0.2$  birds per five-minute point count was significantly greater than the Kingman average of  $0 \pm 0.2$ . Significance of the differences between Common Grackle at Kingman and Kenilworth did not extend beyond this one sampling period, winter of 2004.

## Spring

Of the eleven species that occurred as spring dominants at Kingman and/or Kenilworth (**Fig. 7**), only four were common to both sites: Canada Goose (overall average across sites and years of  $12.7 \pm 4.1$  birds observed per five-minute point count), Ring-billed Gull ( $3.5 \pm 1.0$ ), Crow sp. ( $1.4 \pm 1.5$ ), and Mallard ( $1.1 \pm 0.4$ ). Although these species made our arbitrary cut as spring dominants, none of them occurred in significantly greater numbers in the spring compared to other seasons of the year. None of the spring comparisons between Kingman and Kenilworth were statistically significant for these species.

Five additional species qualified as spring dominants at Kingman in one or more years: Fish Crow (average at Kingman across years of  $1.0 \pm 0.2$ ), European Starling ( $0.8 \pm 0.7$ ), Cedar Waxwing ( $0.7 \pm 0.3$ ), Chimney Swift ( $0.7 \pm 0.2$ ), and American Green-winged Teal ( $0.7 \pm 0.1$ ). Statistically significant differences between sites, years, and seasons for these spring dominants were limited to American Green-winged Teal, which was present in significantly greater numbers in the spring than in any of the other seasons, with greater numbers at Kingman than at Kenilworth overall, and most prominently in the spring of 2001, when Kingman averaged  $1.1 \pm 0.2$  birds observed per five-minute point count compared to Kenilworth's  $0 \pm 0.2$ . Cedar Waxwing appeared at relatively high numbers at Kingman only in the spring of 2002 ( $2.8 \pm 0.5$ ). None of the biologically significant comparisons for this species were statistically significant.

Two species appeared as spring dominants for Kenilworth, but not for Kingman: Red-winged Blackbird (average at Kenilworth across years of  $1.6 \pm 0.6$  compared to Kingman's average of  $0.4 \pm 0.5$ ) and American Crow ( $0.6 \pm 0.2$  for Kenilworth compared to  $0.2 \pm 0.2$  for Kingman). Neither of these two species occurred in greater numbers in the spring than in any of the other seasons, and although they made the cut for spring dominants at Kenilworth and not at Kingman, from the statistical standpoint these two species did not occur in significantly different numbers between these two sites during the spring seasons (for statistical differences involving Red-winged Blackbird and American Crow, see the discussions of fall and winter dominants, respectively).

## Summer

Ten species were categorized as summer dominants for Kingman and/or Kenilworth (**Fig. 8**). Only three of these species occurred as summer dominants at both sites: Canada Goose (overall average across years and sites of  $13.5 \pm 4.1$  birds observed per five-minute point count), European Starling ( $3.1 \pm 0.5$ ), and Chimney Swift ( $1.3 \pm 0.2$ ). European Starling and Chimney Swift (Chimney Swifts migrate to this area to breed during the summer) occurred at significantly greater numbers during the summer season than all other seasons (see the discussion of winter dominants for the Canada Goose seasonal peak). This summer peak for European Starling was driven by the Kingman numbers, with significantly greater summer averages at Kingman ( $5.7 \pm 0.7$ ) than at Kenilworth ( $0.4 \pm 0.8$ ). Statistical significance of the between-site differences for specific years was limited to the summer of 2001, when Kingman averaged  $7.8 \pm 1.1$  compared to Kenilworth's  $1.1 \pm 1.1$ . Chimney Swift, on the other hand, averaged significantly higher at Kenilworth ( $2.1 \pm 0.3$  birds observed per five-minute point count) than at Kingman ( $0.6 \pm 0.2$ ) during the summer seasons. Statistical significance of the between-site differences for specific years was limited to the summers of 2003 and 2004, when Kingman averaged  $2.7 \pm 0.5$ , and Kenilworth averaged  $0.2 \pm 0.4$  and  $0.3 \pm 0.4$ , respectively.

Mallard, Great Blue Heron, Great Egret, and Killdeer occurred as summer dominants at Kingman, but not at Kenilworth, although none of the between-site summer comparisons for these species proved statistically significant. Overall summer averages for these species at Kingman and Kenilworth, respectively, were  $2.3 \pm 0.6$  and  $0.2 \pm 0.7$  for Mallard,  $0.9 \pm 0.1$  and  $0.2 \pm 0.2$  for Great Blue Heron,  $0.9 \pm 0.4$  and  $0.7 \pm 0.4$  for Killdeer, and  $0.6 \pm 0.1$  and  $0.2 \pm 0.1$  for Great Egret. Summer represented the seasonal peak for only one of these species, Killdeer.

Red-winged Blackbird, American Crow, and Barn Swallow occurred as summer dominants at Kenilworth, but not at Kingman. Overall summer averages for these species at Kenilworth and Kingman, respectively, were  $1.8 \pm 0.6$  and  $0.7 \pm 0.5$  for Red-winged Blackbird,  $0.4 \pm 0.3$  and  $0.4 \pm 0.2$  for American Crow, and  $0.7 \pm 0.1$  and  $0.5 \pm 0.1$  for Barn Swallow. None of the summer differences between sites for these species were statistically significant. Barn Swallow was the only species of the three whose summer numbers represented a statistically significant seasonal peak, and this was true for both Kenilworth and Kingman. Barn Swallows were particularly abundant at Kenilworth during the summer of 2002, when they were significantly more abundant during the summer than during the other seasons of 2002, and significantly more abundant than during the summer of 2001. Such Barn Swallow observations are consistent with their migratory patterns since they fly south for the fall-winter seasonal period. Other comparisons were not statistically significant.

## Fall

Eight species were identified as fall dominants at both Kingman and Kenilworth (**Fig. 9**). Overall fall averages for these species at Kingman and Kenilworth, respectively, were  $17.7 \pm 5.6$  and  $7.6 \pm 5.9$  for Canada Goose,  $3.3 \pm 0.7$  and  $1.7 \pm 0.7$  for European Starling,  $1.1 \pm 0.7$  and  $2.0 \pm 0.7$  for Crow species,  $1.6 \pm 0.6$  and  $1.8 \pm 0.6$  for Mallard,  $0.4 \pm 0.4$  and  $1.0 \pm 0.4$  for Killdeer,  $0.5 \pm 0.5$  and  $4.0 \pm 0.6$  for Red-winged Blackbird,  $1.5 \pm 1.4$  and  $1.2 \pm 1.5$  for Ring-billed Gull, and  $0.5 \pm 0.2$  and  $0.4 \pm 0.2$  for Fish Crow.

Canada Goose, Ring-billed Gull, and Fish Crow made the cut for fall dominants, although the fall did not represent a seasonal peak for any of these species. None of the differences between sites were statistically significant for these species. For European Starling, Mallard, and Killdeer, abundances for the fall season were significantly greater than one or more of the other seasons, even though fall was not the primary seasonal peak. Again with this group of species, there were no significant differences between sites. Crow species showed significantly elevated abundances at both sites in the fall of 2001 only. Of the fall dominants common to both sites, Red-winged Blackbird was the only one that showed a primary seasonal peak in the fall, and the only one that showed statistically significant differences between sites in the fall season. This statistical significance extended beyond the fall season to the overall numbers irrespective of season, with greater numbers of Red-winged Blackbird observed at Kenilworth than Kingman.

Great Blue Heron was the only species identified as a fall dominant at Kingman, but not at Kenilworth. From the statistical standpoint, significantly greater numbers of birds were observed at Kingman during the fall season, than at Kenilworth (averages of  $0.8 \pm 0.1$  and  $0.2 \pm 0.2$ , respectively). In fact, significantly greater numbers of Great Blue Herons were observed at Kingman than at Kenilworth, irrespective of season ( $p = 0.0135$ ).

American Crow and Chimney Swift were the only species identified as fall dominants at Kenilworth, but not at Kingman, although fall was not a seasonal peak for either species, and there were no significant differences between sites for these species. Fall averages at Kingman and Kenilworth were  $0.3 \pm 0.2$  and  $0.9 \pm 0.2$  for American Crow, and  $0.3 \pm 0.2$  and  $0.7 \pm 0.2$  for Chimney Swift.

Great Egret did not make the cut off for fall dominant at either site, but it is mentioned because the statistical results indicated that significantly greater numbers of Great Egrets occurred at Kingman ( $0.6 \pm 0.1$ ) than at Kenilworth ( $0.2 \pm 0.1$ ) during the fall season.

### **Seasonal Dominants by Species**

#### American Green-winged Teal

Presence of the American Green-winged Teal is highly seasonal, with significantly greater numbers occurring in spring than in all other seasons, and significantly greater numbers occurring at Kingman during the spring than at Kenilworth ( $p = 0.0151$ ). Even at Kingman during the spring, numbers are still low, averaging only  $0.7 \pm 0.1$  birds observed during a five-minute point count. The spring counts occurred before the birds migrated north to breed.

#### American Crow

Numbers of American Crow observed depended on the year ( $p = 0.0013$ ) and the season ( $p = 2.8E-07$ ), with significantly greater averages in 2001 ( $1.2 \pm 0.2$  birds per five-minute point count) than in 2003 or 2004, and significantly greater averages in the winter ( $1.6 \pm 0.2$ ) than in all other seasons. None of the biologically significant pairwise comparisons between Kingman and Kenilworth proved statistically significant.

#### Barn Swallow

Barn Swallow numbers were significantly influenced by season ( $p = 1.06E-12$ ) and the interaction between season and year ( $p = 0.0028$ ), with the greatest averages occurring in the summer season ( $0.6 \pm 0.1$ ), and more specifically in the summer of 2002 ( $1.1 \pm 0.1$ ). None of the biologically significant pairwise comparisons between Kingman and Kenilworth proved statistically significant.

#### Canada Goose

Season, area, and the season by area interaction were all statistically significant factors affecting the Canada Goose numbers ( $p = 6.93E-05$ ,  $p = 0.0368$ , and  $p = 0.0009$ , respectively). Winter averages were the greatest ( $23.8 \pm 4.2$ ), irrespective of year and area. Canada Goose numbers averaged significantly greater at Kingman than at Kenilworth, during the winter season ( $39.0 \pm 6.0$  compared to  $8.6 \pm 5.8$ ) and overall ( $24.8 \pm 5.3$  compared to  $7.0 \pm 5.5$ ).

#### Cedar Waxwing

Cedar waxwing appeared primarily during the spring migration of 2002 at Kingman, when it averaged  $2.8 \pm 0.5$  birds observed during a five-minute point count. None of the biologically significant pairwise comparisons between Kingman and Kenilworth proved statistically significant.

### Chimney Swift

Numbers of Chimney Swift were significantly influenced by season ( $p = 1.55\text{E-}08$ ) and the season by area ( $p = 0.0001$ ) and year by season by area interaction terms ( $p = 0.0062$ ). Chimney Swift were most abundant in the summer (as might be expected due to their migration to this area to breed), when they averaged  $1.3 \pm 0.2$  birds observed per five-minute point count. Overall summer averages were greater at Kenilworth ( $2.1 \pm 0.3$ ) than at Kingman ( $0.6 \pm 0.2$ ); during 2003 and 2004 summer averages at Kenilworth were significantly greater than at Kingman.

### Common Grackle

Common Grackle appeared during the winter of 2004 at Kenilworth, when its average of  $1.1 \pm 0.2$  birds per five-minute point count was significantly greater than the Kingman average of  $0 \pm 0.2$ .

### Crow species

Crow species numbers were greatest in the winter season, averaging  $4.7 \pm 0.6$  birds observed per five-minute point count. Significant differences between Kingman and Kenilworth were limited to the winter of 2001, when more birds were observed at Kingman ( $12.7 \pm 1.2$ ) than at Kenilworth ( $1.2 \pm 1.2$ ).

### European Starling

Presence of European Starling was seasonal, with the greatest numbers observed in the summer season ( $3.1 \pm 0.5$ ), followed by the fall ( $2.5 \pm 0.5$ ). More European Starling were observed during the summer season at Kingman ( $5.7 \pm 0.7$ ) than at Kenilworth ( $0.4 \pm 0.8$ ).

### Fish Crow

Fish Crow averages were greater during the winter season ( $1.4 \pm 0.2$ ) than during the other seasons. Averaging over all the seasons, significantly more Fish Crow were observed at Kingman ( $1.0 \pm 0.1$ ) than at Kenilworth ( $0.5 \pm 0.2$ ).

### Great Black-backed Gull

Overall, numbers of Great Black-backed Gull averaged significantly greater during the winter months ( $0.7 \pm 0.4$ ) than during the other seasons (when they had migrated). The statistical significance of the season by area interaction term ( $p = 1.16\text{E-}14$ ) indicates that the areas are behaving differently with respect to the seasons, with Kingman exhibiting a seasonal pattern peaking in the winter ( $0.5 \pm 0.7$ ) and Kenilworth's numbers remaining flat across the seasons (averaging  $0.8 \pm 0.5$  overall).

### Great Blue Heron

Overall, significantly more Great Blue Heron have been observed at Kingman (average of  $0.7 \pm 0.1$  birds per five-minute point count) than at Kenilworth ( $0.2 \pm 0.1$ ;  $p = 0.0135$ ). At the seasonal level, this difference was statistically significant only during the fall season.

### Great Egret

Great Egret numbers were significantly greater during the summer and fall seasons (average of  $0.4 \pm 0.1$  for each) than during the winter or spring ( $0 \pm 0.1$  for each). Statistical differences between Kingman and Kenilworth were limited to the fall season ( $p = 0.0167$ ), when greater numbers of Great Egret were observed at Kingman ( $0.6 \pm 0.1$ ) than at Kenilworth ( $0.2 \pm 0.1$ ). Great Egrets tend to shift south for the winter period.

### Killdeer

Year and season played significant roles in determining numbers of Killdeer observed during the study ( $p = 0.0007$  and  $p = 0.0016$ , respectively), with significantly greater numbers observed during the summer season ( $0.8 \pm 0.3$ ) than during the spring or winter seasons ( $0.2 \pm 0.3$  each), and significantly greater numbers were observed in fall ( $0.7 \pm 0.3$ ) compared to spring. There were no significant differences between the numbers of Killdeer observed at Kingman and Kenilworth. It may be that the Killdeer use the newly formed open sediments for feeding in a manner similar to fields which is their more common habitat.

### Mallard

Greater numbers of Mallard were observed during the winter season ( $2.8 \pm 0.5$ ) than during spring ( $1.1 \pm 0.4$ ), summer ( $1.2 \pm 0.4$ ), or fall ( $1.7 \pm 0.4$ ). No significant differences were observed between Kingman and Kenilworth.

### Ring-billed Gull

Ring-billed Gull were most abundant during the winter season, when they averaged  $11.5 \pm 1.1$  birds observed during a fine-minute point count. Significantly more of these birds were observed at Kingman ( $16.2 \pm 1.5$ ) than at Kenilworth ( $6.9 \pm 1.5$ ) during the winter seasons. Ring-billed Gull were particularly abundant at Kingman during the winter of 2001 when an average of  $24.2 \pm 2.0$  birds were observed per five-minute point count. This was significantly greater than at Kenilworth during the same timeframe ( $7.5 \pm 2.0$ ), as well as Kingman itself during the winter of 2002 ( $6.8 \pm 1.7$ ).

### Red-winged Blackbird

Significantly greater numbers of Red-winged Blackbird were observed during the fall season ( $2.2 \pm 0.4$ ) than during all the other seasons. Overall, significantly greater numbers of Red-winged Blackbird were observed at Kenilworth ( $2.0 \pm 0.5$ ) than at Kingman ( $0.4 \pm 0.4$ ). This was most pronounced in the fall season, when Kenilworth averaged  $4.0 \pm 0.6$  birds observed per five-minute point count, compared to Kingman's  $0.5 \pm 0.5$ . The fall of 2004 produced the only significant difference within an individual seasonal sampling period, when Kenilworth averaged  $5.9 \pm 0.1$  birds and Kingman averaged  $0.1 \pm 0.8$ .

### **Abundances of wetland users**

Among the birds observed during the course of the study we identified a functional group of wetland users based on the categorizations provided in Illif et al (1996). All species observed during the study and recognized as users of the types of wetlands associated with the Kingman and Kenilworth sites (i.e., fresh marshes, tidal mudflats, bottomland forests, rivers, and estuaries) were included in this group (**Table 5**). Canada Goose is included on the list, but was not

included in the statistical analysis, since Canada Goose has already been analyzed and graphed separately, and the magnitude of the Canada Goose numbers would be likely to obscure patterns associated with the other wetland and marsh users.

Table 5 includes birds observed at both Kingman and Kenilworth in the two years prior to the Kingman reconstruction – 1999-2000 (Dawson and Gough, 2001), as well as in the current four-year post-reconstruction study. Sixty-six wetland species were observed at Kingman and 55 at Kenilworth during the pre-reconstruction study, forty-one of which were observed at both sites. Of the wetland user species observed during the 2001 through 2004 study, 83 were observed at both sites.

Most of the wetland user species observed during the 1999-2000 study were observed again at those same sites in the 2001 through 2004 study (89% and 93% at Kingman and Kenilworth, respectively). Many more wetland user species were observed during the post-reconstruction study compared to the pre-reconstruction study (99 species compared to 66 at Kingman, and 115 compared to 55 for Kenilworth). These differences undoubtedly reflect differences in study duration, sampling frequency, exact data collection locations and personnel. Given the differences in data collection between the two time periods, it is not possible to determine whether the differences in numbers of wetland species observed over time reflect data collection differences only, or something of more significance.

Results of the statistical analyses of the 2001 through 2004 point-count data indicate that wetland user abundances were highly seasonal (**Fig. 10a**), with a significantly greater number of birds observed in winter (average of  $19.3 \pm 1.6$  wetland users observed per five-minute point count) than in spring, summer, or fall (averages of  $12.2 \pm 1.6$ ,  $10.2 \pm 1.6$ , and  $11.0 \pm 1.5$ , respectively). Results also indicate that the significance of differences in wetland user abundances between Kingman and Kenilworth depend on both season and year. Excluding Canada Goose (which show a pattern similar to the other wetland users), a significantly greater number of wetland users have been observed at Kingman than at Kenilworth during the winter seasons ( $25.0 \pm 2.3$  and  $13.6 \pm 2.3$ , respectively).

Some insights into the composition of this winter peak in wetland users at Kingman can be obtained by looking again at Kingman's winter dominants (**Fig. 6**). Of the eight winter dominants identified at Kingman, six are considered wetland as well as open water users: Canada Goose (excluded from this analysis), Ring-billed Gull, Mallard, Fish Crow, Great Blue Heron, and Great Black-backed Gull. Kenilworth also exhibited greater abundances in winter than in summer, although none of the differences were statistically significant.

Year also influenced the magnitude and statistical significance of the winter differences between Kingman and Kenilworth; 2001 was the only individual year in which the differences in winter wetland abundances between Kingman and Kenilworth were statistically significant (with 2001 winter averages per five-minute count of  $33.6 \pm 2.9$  and  $13.0 \pm 3.0$ , respectively).

Two additional points are worth noting regarding the wetland user abundance data. One is that the data suggest that the wetlands may have as great or even greater importance during the winter

as refugia than during the growing seasons when the marsh vegetation is growing and abundant. The other is that although Kingman is exhibiting significantly greater numbers of wetland users than Kenilworth during the winter seasons, the two sites appear to be behaving similarly during the spring, summer, and fall seasons. The Kingman Marsh attraction during the winter may also be related to the proportionally increased open water and mudflat resulting from vegetation and detrital decline following herbivory.

### **Abundances of Freshwater Marsh Users**

Since the intent of this project was to create more freshwater marsh habitat, the abundance of birds known to use freshwater marsh habitats (Illif et al, 1996) was extracted from the larger wetland grouping and analyzed separately. **Table 2** provides a list of the birds observed at Kingman and Kenilworth that are normally considered freshwater marsh users and that were included in this list; **Figure 10b** illustrates marsh user abundances over time.

The analytical results indicate that averaging across sites and years, significantly more marsh users are found in the fall than in all the other seasons. This pattern is driven by the numbers at Kenilworth, where significantly greater numbers of marsh users have been observed in the fall ( $7.1 \pm 0.9$  birds observed per five-minute point count) than in the winter ( $3.6 \pm 0.9$ ), spring ( $3.7 \pm 0.9$ ), or summer ( $3.3 \pm 0.9$ ). Red-winged Blackbird, which exhibits a similar pattern of a statistically significant fall peak at Kenilworth, undoubtedly plays an important role in this marsh user pattern.

Approximately the same number of marsh users were observed overall at Kingman ( $4.8 \pm 0.7$ ) compared to Kenilworth ( $4.4 \pm 0.7$ ), but the temporal distribution of birds was different. Kenilworth exhibited seasonal peaks in the fall, while at Kingman numbers were more influenced by year than by season, with significantly greater numbers observed in 2002 than in 2003 or 2004.

Freshwater marsh species with total 4-year abundances of 10 or more at either site (**Table 2**) were also analyzed individually. Species occurring in significantly great abundances to have met the criterion for seasonal dominant have already been analyzed and discussed in the section on seasonal dominants. Of the remaining species, four exhibited statistically significant differences between sites during one or more seasons. Black-crowned Night Heron and Lesser Yellowlegs occurred at significantly greater numbers at Kingman than at Kenilworth during the summer and fall seasons, respectively. Wood Duck and Common Yellowthroat occurred at significantly greater numbers at Kenilworth than at Kingman overall, during the spring for Wood Duck, and both spring and summer for Common Yellowthroat.

In conclusion, the large picture suggests that there are many similarities in freshwater marsh user abundances between Kingman and Kenilworth. They do not differ significantly in terms of overall abundances averaged across year and season. None of the differences between the sites within a sampling event were statistically significant, which is not surprising given the variability displayed in **Figure 10b**. They do exhibit differences in wetland user abundance at a finer scale, however, with Kenilworth exhibiting a significant fall peak not exhibited by Kingman. And, as discussed in the section on seasonal dominants, there are differences in the species composition of the wetland users at the two sites, with species such as Red-Winged Blackbird, Wood Duck,

and Common Yellowthroat more common at Kenilworth, and species such open water users as Great Blue Heron, Great Egret, and Black-crowned Night Heron more common at Kingman (at least seasonally).

### **Abundances of Mudflat/Shorebird Species**

Significantly more mudflat/shore habitat users were observed (**Fig. 10c**) in the winter seasons (averaged across years) at Kingman than at Kenilworth (winter averages of  $16.8 \pm 1.8$  and  $7.4 \pm 1.8$ , respectively). This effect was most pronounced in the winter of 2001 (the only individual sampling event with a statistically significant difference between sites), when Kingman averaged  $24.6 \pm 2.3$  and Kenilworth averaged  $8.4 \pm 2.3$ .

The statistical analysis of the mudflat/shore user guild used the 5-minute point count data for the species listed in **Table 4**. Of these individual species, only Ring-Billed Gull (discussed under seasonal dominants) and Lesser Yellowlegs exhibited statistically significant differences between Kingman and Kenilworth, with significantly greater numbers of Ring-Billed Gull occurring at Kingman compared to Kenilworth in the winter seasons and significantly greater numbers of Lesser Yellowlegs occurring at Kingman compared to Kenilworth in the fall seasons.

### **DISCUSSION:**

This study was initially established to try to use birds as an indicator of the progress of marsh restoration following reconstruction at Kingman (2000), particularly in relation to Kenilworth Marsh which had been reconstructed 7 years prior (1993) and to nearby freshwater tidal wetlands as reference sites based on bird lists provided by others. The course of events as controlled by excessive goose grazing at Kingman prevented what might have been a normal pattern of restoration at Kingman. Goose grazing impacts were much less severe at Kenilworth. Thus one might expect differences between these two reconstructed marshes based upon structure and not find nearly so much developed similarity as had been hoped based on restoration success. It is also true that both of these reconstructed wetlands are rather small (30-40 acres) and in fact each actually consists of two discrete areas creating a relatively large edge effect. There is also the adjacent mainstem of the Anacostia which will attract some water birds and supplements the reconstructed wetland habitat. Thus a certain amount of bird usage may occur that has little to do with the reconstructed wetlands. All this is to say that while the bird usage did tell us much about the status of the reconstructed wetland habitat, some of the results are surely blurred by these circumstances.

The inferences that can be drawn from the results at one treatment site compared with a second treatment site of a different age may be limited. Each Anacostia study site has had its own setbacks. Kenilworth has had problems with invasive plant species and thus has necessitated herbicide treatments to remove *Phragmites* and to some extent purple loosestrife. Kingman has suffered a great loss of habitat with respect to vegetation decline from goose grazing and sediment elevation loss or sediment consolidation in local areas. Habitat is critical for avian species and it is what may attract or deter a species from occupying an area. If the area is attractive and supports food and cover, species that prefer that type of habitat may utilize it. Where the vegetative communities and physical habitats are different, their bird communities will likely be different. Looking at just the marsh birds, there are a greater number of species

that seem to prefer Kenilworth to Kingman but many species enjoy both sites in relative equal abundance and/or frequency. Kenilworth hosts a greater abundance of Red-winged Blackbirds and in migration Rusty Blackbirds can be observed. Some birds are rare or occasional visitors. The surrounding habitat certainly influences the birds' preference as well. With respect to mudflat habitats, shorebirds are in greater abundance at Kingman. With the strong grazing pressure on the wetland, more mudflat habitat (unvegetated areas) has been exposed and this in turn attracts the greater number of shorebirds feeding on the macro benthic community there (primarily oligochaetes and chironomids).

Overall, Kingman has attracted greater abundance of cormorants, herons, waterfowl, shorebirds, gulls, and terns. This may be due to the more open water in the area. Since we controlled for tidal level during the sampling, it should not be due to greater proportion of the sampling occurring during low tide at Kingman. For passerines, Kingman has had greater abundance of marsh and house wrens, thrushes, mockingbird, starlings and waxwings. Some of these species prefer the edge and open areas that occur around the golf course.

The birds that seem to prefer the Kenilworth wetland habitat are Wood Ducks, American Black Duck, Common Yellow Throated Warbler and Red-winged Blackbirds. The blackbirds may have been especially attracted in the fall at Kenilworth to the presence of an increasing concentration of naturally occurring wild rice (*Zizania aquatica*). With additional plantings of fence protected wild rice by the Anacostia Watershed Society in 2005 at Kingman Marsh an increase in blackbirds and other seed eaters might be expected there. Osprey and Belted Kingfisher were more abundant at Kenilworth but they occur in open water habitat. Red-shoulder Hawk, Eastern Phoebe, Carolina Wren, Winter Wren, Kinglets, Blue-gray Gnatcatcher, and warblers also occurred in greater abundance in wood margins and or bottomland forests at Kenilworth.

### **Comparison to other nearby wetlands**

Total number of bird species observed at four somewhat different but regionally located tidal wetlands was looked at as a project goal to draw some comparisons to the populations at the reconstructed Kingman and Kenilworth Marshes (177 species observed over 4 years (2001-2004)). Unfortunately, the information was not collected in the same manner or time period at any of the sites but is simply derived from total species lists not necessarily with consideration of total bird counts or frequency. In general the list of bird species for the Anacostia that are associated with freshwater tidal wetlands compares quite closely to the following wetlands. What might be most valuable in going over these reference lists would be to note wetland users not currently found or common in the Anacostia but might be expected to once more sufficient habitat is developed. It should also be noted that two of the wetlands (Ft. McHenry and Hart-Miller) are in urbanized or highly disturbed locations. Unlike these other wetlands, the reconstructed marsh pieces in the Anacostia do not function as a unit and thus a suggested goal for the Anacostia would be to try expanding the wetland habitats at and between each of the segregated wetlands.

A much larger nearby, but more rural and complex wetland is the Patuxent River Marsh – Jug Bay area where 273 species have been observed with over 100 confirmed nesting. Staff and volunteers combined resources to produce a checklist. Jug Bay is a freshwater tidal marsh with

large concentrations of waterfowl and wading birds. It is a critical stopover for many Neotropical migrants. There are a variety of habitats for birds here to include open water, tidal freshwater marshes, tidal mudflats, shrub-scrub swamps, forested uplands and open fields. The immediate wetland has a 15-mile circumference and is comprised of 2000 acres. This size and location must be kept in mind when comparing to Kingman and Kenilworth. The American Bird Conservancy has designated Jug Bay a "Nationally important bird area" because of its high numbers and diversity of birds. Key bird species that are missing from the Anacostia but at Jug Bay include Least Bittern, Virginia Rail, King Rail, Forster's Tern, Red-throated Loon and Tundra Swan.

Dyke Marsh Preserve is the last remaining major tidal freshwater wetland on the upper tidal Potomac River. It lies just south of Washington D.C. and Alexandria along the Virginia shore. This preserve encompasses 550 acres of developed parkland, river shoreline and marsh. A portion (about one third) of the original emergent marsh was dredged for sand and gravel. The park extends from Alexandria City line south along the Potomac for 2 ½ miles. A total of 246 species have been observed through 2000 and reflects over 50 years of observations by many people (Johnston, 2000). Essentially all of the bird species observed at the Anacostia wetlands have been observed at Dyke Marsh (except for the rare chance sighting of the American woodcock and Glossy ibis). Species of interest for the Anacostia that have been observed at Dyke Marsh include those noted from the Patuxent as well as possibly Common Moorhens, Common Snipe (have been observed at Kingman Marsh) and possibly owl species (night time observations have not been conducted at Kingman Marsh) that may have association with wetlands. Probably the biggest challenge for the Anacostia is to increase wetland habitat (mudflats and emergent wetlands) so that greater numbers of birds will use the estuary.

A third nearby wetland that has been very intensively monitored occurs at Fort McHenry in Baltimore. This is a 7-acre constructed marsh with 3 acres of upland that has been monitored by Jim Peters from 1999-2004 (a similar period of observation to that for the Anacostia wetlands), which is approximately the same time period that the Anacostia wetlands have been monitored in this study. He monitors the wetland 5-6 hours daily for much of the year. There are no point counts, only repeated walk-throughs. There have been a total of 217 species reported in 4 ½ years but in a 'normal' year such as 2000 the list of observed bird species numbered 120. The multi-year total is 56 less species than at Jug Bay and 43 more than for Kingman and Kenilworth combined. Virginia and Sora Rails have been observed in migration. Virginia rails tried to nest there but were flooded out by the tides. Based on the small size and highly urban character of the Ft. McHenry Marsh, this suggests a real opportunity for the Anacostia as a place for such species to re-establish. There is a large Swamp Sparrow population present at Fort McHenry. Most of the bird species observed at Ft. McHenry were also observed in the Anacostia with the exception of open water waterfowl (Anseriformes) like Grebes, Widgeons, Scaups, Bufflehead, etc. possibly because the water at Ft. McHenry may be more brackish.

Another Army Corps of Engineers reconstructed wetland (but non-tidal) is at Hart-Miller Island in Baltimore. There is an elevated wetland perched 30-40 feet above sea level on top of dredge spoil material, as well as the large disposal area that attracts considerable numbers of shore birds. Since 1977 there have been 275 species recorded on or around the island including 13 breeding birds.

## CONCLUSIONS:

While the use of birds as an indicator parameter of reconstructed marsh progress became obstructed for this study due to the interruption of Kingman Marsh development as a consequence of herbivory and lowered sediment elevations, a number of vital pieces of information were obtained. The size of each reconstructed wetland is small (<35 acres) making it difficult to determine whether it was the reconstructed wetland itself or some other (surrounding) habitat component(s) that attracted any bird species.

A total of 177 species of birds were observed at both Kingman and Kenilworth combined (almost 14 taxonomic orders and 16 families) for all four years of the study with Kingman showing 137 and Kenilworth 164. Of importance, reflecting overall similarity of habitat as far as bird species are concerned, is that 124 of the species were found at both wetlands.

From the statistical standpoint, over the course of the four-year study, despite fewer species, Kingman has seen greater abundances than Kenilworth of all birds combined, as well as all birds other than Canada Goose. There is a seasonal component to these differences, with statistical significance of the differences between sites limited to the winter season. Differences between the sites during the growing season were not statistically significant, suggesting that these marshes may provide more of a winter refugium than might have been expected. The wetlands may have as great or even greater importance during the winter as refugia than during the growing seasons when the marsh vegetation is alive and abundant.

Wetland users (non-Canada Goose) proved more abundant during the winter seasons, especially at Kingman, where they were observed in significantly greater numbers than at Kenilworth, but were similar at both sites for the other seasons.

Kingman has also seen greater abundances of Canada Goose than have been observed at Kenilworth. There is a seasonal component to these Canada Goose differences, with statistical significance of the differences between sites limited to the winter season. During the growing season, when the vegetation would be expected to be most vulnerable to herbivory, there were no significant differences between Kingman and Kenilworth with respect to the numbers of Canada Goose (resident) observed. In terms of the individual sampling periods, Canada Goose means were greater at Kingman than at Kenilworth in each of the 16 seasonal sampling periods, although none of the individual Tukey results proved statistically significant. Canada Goose exhibited a statistically significant decline from 2002 to 2004, which is not attributable to the egg-oiling operations, since these were not started until 2004. The egg oiling has not had a statistically significant impact on the numbers of Canada Goose young observed, either, although this may be attributable at least in part to the limitations of the data set and the patchiness of encounters with broods during the five-minute point count.

Species richness (averaged across sites) was significantly greater during the spring and summer seasons than during the fall and winter seasons (mostly due to migrants). None of the differences observed between sites within sampling periods or within seasons were statistically significant.

Many of the seasonal dominants identified during the course of the study were common to both Kingman and Kenilworth, including such disturbed area species as Canada Goose, Ring-billed Gull, Crows, Mallard, and European Starling. Other species (only some of which were abundant enough to be classified as dominants) were significantly more abundant at one site than the other (either seasonally or across seasons), including Great Blue Heron, Great Egret, Black-crowned Night Heron, and Lesser Yellowlegs at Kingman, and Red-Winged Blackbird, Wood Duck, and Common Yellowthroat at Kenilworth.

Three functional guilds were identified and analyzed for this study. Wetland users comprised the largest guild, and consisted of those species known to use all the types of wetland habitat associated with the marsh restorations (e.g., freshwater marshes, tidal mudflats, bottomland forests). Two additional subgroups were broken out of this larger list for separate analysis, Freshwater marsh users and Mudflat/shore users. Canada Goose was not included in these analyses, since they were already analyzed separately, and it was thought that they would overwhelm the results for other users. Wetland user results appear to be driven by the Mudflat/shore user results, exhibiting similar patterns of seasonality and statistical significance, with greater numbers observed at Kenilworth during the winter seasons. Greater numbers of the Mudflat and Shore users observed at Kingman probably relate to the larger amount of mudflat and open water associated with Kingman. Also, many of the gulls are much more common around the wetlands in winter.

In contrast, the Marsh users are most abundant in the fall seasons. Although the species composition of Marsh users has been shown to differ between the two sites (e.g., more Red-Winged Blackbirds at Kenilworth, more Great Blue Herons and Great Egrets at Kingman), in terms of overall numbers of Marsh users observed at the two sites, none of the differences within sampling periods or seasons were statistically significant.

## **RECOMMENDATIONS**

Given the interruption of development of emergent marsh habitat at Kingman, it is clear that as much of that habitat should be restored as possible. One likely component of restoration should involve reduction of the Canada Goose herbivory pressure. With much of the marsh sediment elevations lowered, more of the marsh should be restored as low marsh as opposed to the original restoration goal of considerable mid marsh. Many bird species are dependent upon the emergent marsh for shelter and food.

A less disturbed, less fractured but increased marsh environment in the Anacostia should bring about a reduction in the abundance of disturbed area wetland birds and an increase in species richness to bring this estuarine watershed closer to the avian support levels found in nearby more natural marshes and to what bird usage was once found in the Anacostia before the original wetlands were removed. Thus a larger mass of connected wetlands is needed in the tidal Anacostia.

Avian monitoring as an indicator of wetland status should be re-initiated and conducted on a long term basis, focussed at least upon the three wetland habitat dependent groups used in this study; and then especially whenever significant wetland expansion occurs.

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## MAPS

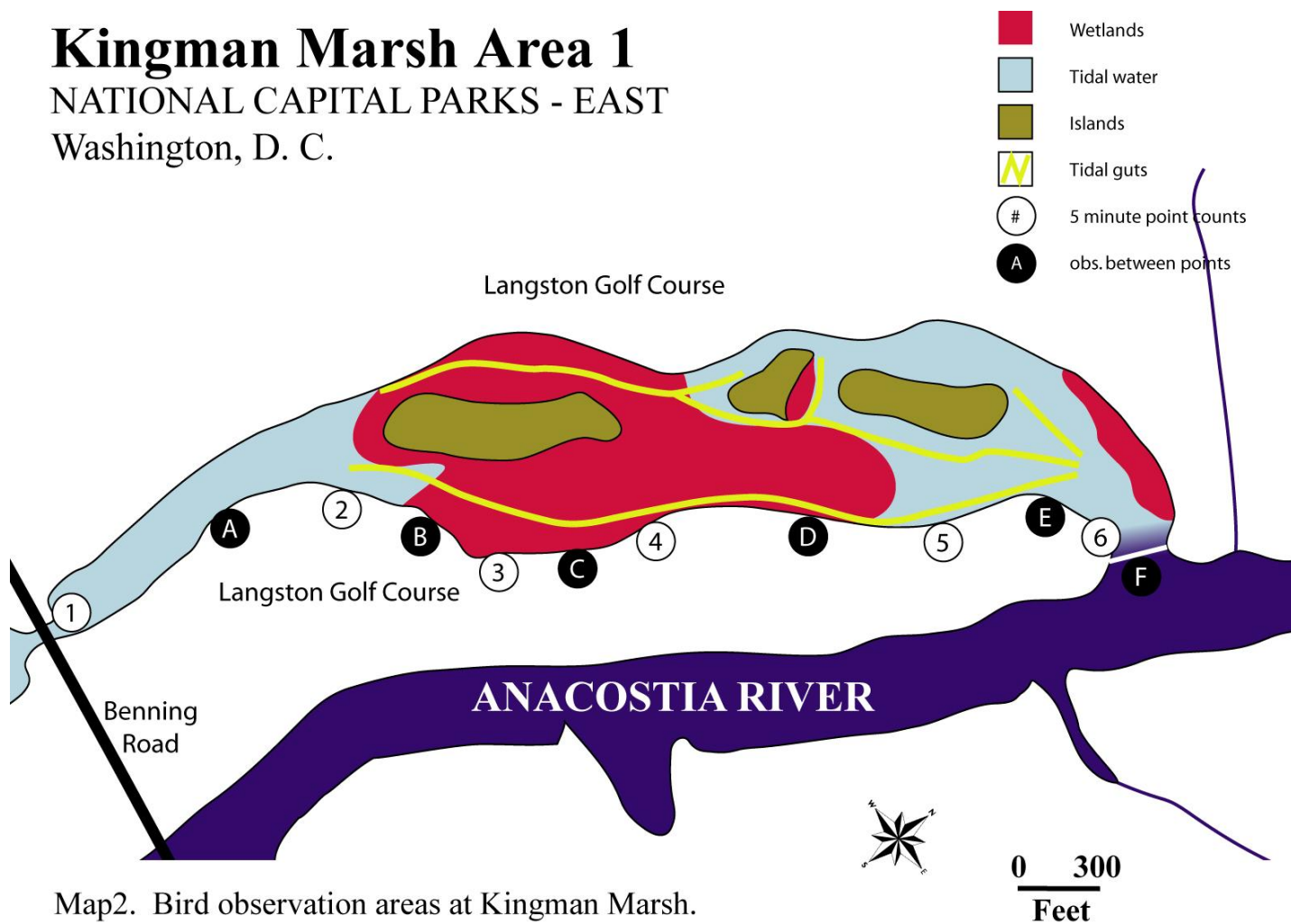


**Map 1. Aerial photograph (2003) of reconstructed Anacostia wetlands. Dates indicate when the wetlands were reconstructed.**

# Kingman Marsh Area 1

## NATIONAL CAPITAL PARKS - EAST

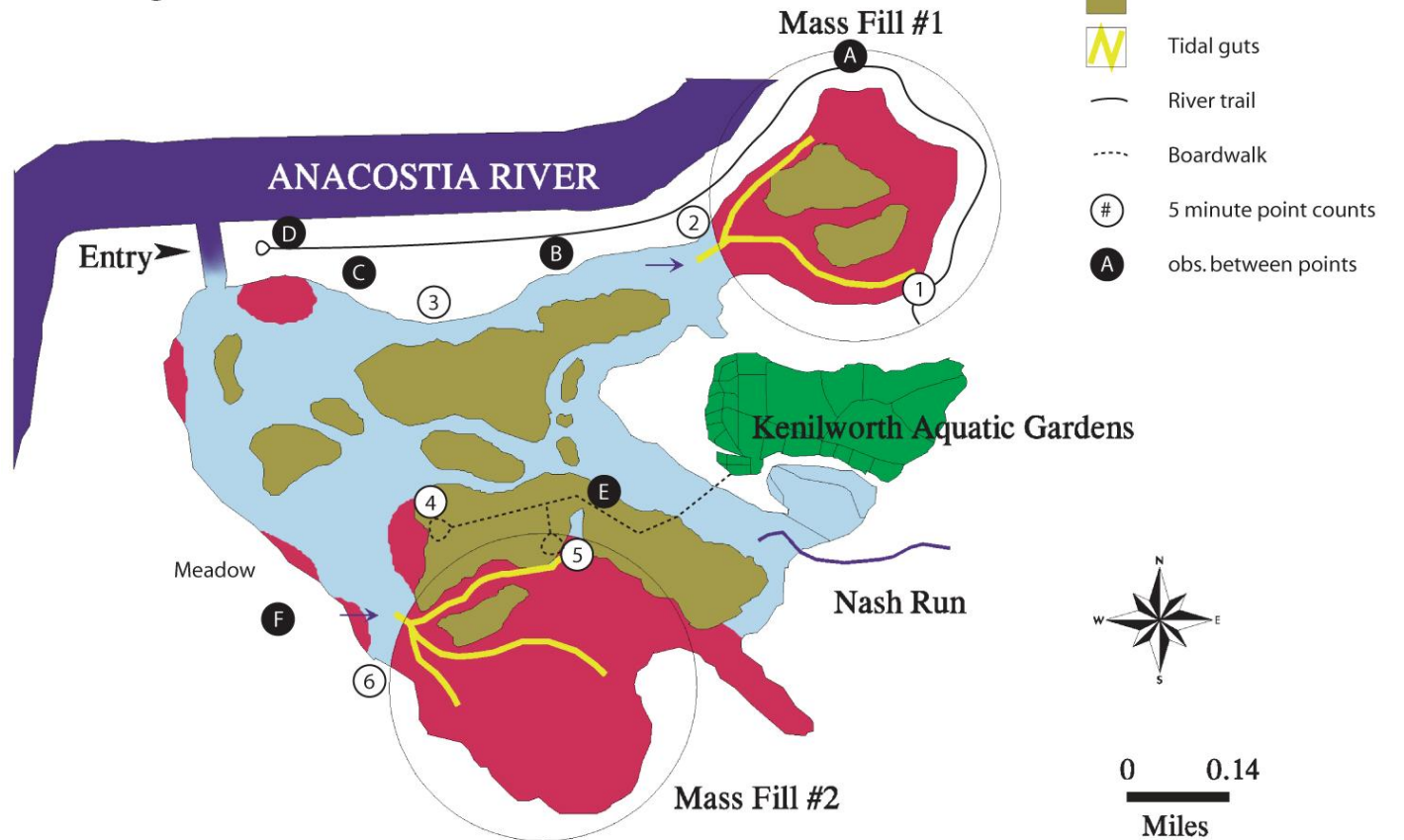
Washington, D. C.



Map2. Bird observation areas at Kingman Marsh.

# Kenilworth Marsh

NATIONAL CAPITAL PARKS-EAST  
Washington, D.C.



Map3. Bird observation areas at Kenilworth Marsh.

Table 1. List of birds sighted during the study with the relative frequencies given for Kingman and Kenilworth Marshes for each year of the study.

**a = Abundant, an obvious or numerous species very likely to be seen or heard**

**c = Common, a species likely to be seen or heard.**

**u = Uncommon, a species usually present on a few days each year during migration**

**r = Rare, a species not present every year or only once or twice a year**

**\* = Migratory birds spending little time in the wetland area**

	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
<b>Species</b>								
<b>Podicipediformes</b>								
Pied-billed Grebe	r	----	----	----	----	r	----	----
<b>Pelecaniformes</b>								
Double-crested Cormorant	c	c	c	c	u	u	c	c
<b>Ciconiiformes</b>								
American Bittern	----	----	----	----	r	----	----	----
Great Blue Heron	a	a	c	c	a	a	c	c
Great Egret	a	a	c	c	a	c	c	c
Snowy Egret	----	----	----	----	r	----	u	r
Little Blue Heron	----	----	r	----	r	r	----	r
Tricolored Heron	----	----	----	----	r	----	----	----
Green Heron	u	r	u	u	u	u	u	u
Black-crowned Night-Heron	u	u	u	u	----	----	----	----
Glossy Ibis	r	----	----	----	----	----	----	----
Black Vulture	----	u	----	----	r	u	u	u
Turkey Vulture	c	c	u	u	c	c	u	u
<b>Anseriformes</b>								
Snow Goose hybrid	----	r	----	----	----	----	----	r
Canada Goose	a	a	a	a	a	a	a	a
Wood Duck	----	u	u	u	a	c	c	c
American Wigeon	----	----	----	----	r	----	----	r

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
American Black Duck	u	u	u	u	u	c	c	c
Mallard	a	a	a	a	a	a	a	a
Blue-winged Teal	----	r	----	----	----	----	r	r
Northern Shoveler	----	----	----	----	r	----	----	----
Northern Pintail	u	----	----	----	u	r	u	u
American Green-winged Teal	u	c	u	u	u	u	u	u
Canvasback	----	----	r	----	----	----	----	----
Ring-necked Duck	----	----	r	----	r	----	----	----
Hooded Merganser	r	u	u	u	u	u	u	u
Common Merganser	r	r	u	u	u	r	u	u
domestic white duck	u	u	u	u	----	r	----	----
domestic (farm) goose	u	r	----	----	----	----	----	----
<b>Falconiformes</b>								
Osprey	u	c	c	c	c	c	c	c
Bald Eagle	u	u	c	c	u	u	c	c
Northern Harrier	c	u	----	u	u	----	r	----
Sharp-shinned Hawk	r	u	u	----	r	----	u	----
Cooper's Hawk	----	u	u	u	r	u	u	u
Red-shouldered Hawk	c	c	c	c	c	c	c	c
Broad-winged Hawk	r	----	----	----	----	----	----	----
Red-tailed Hawk	u	u	u	u	u	u	u	u
American Kestrel	r	r	----	----	r	r	u	u
Peregrine Falcon	r	r	----	----	----	r	----	----
<b>Quail</b>								
Northern Bobwhite	----	----	----	----	r	r	----	----
<b>Gruiformes</b>								
Sora	----	----	----	----	----	----	----	r
American Coot	r	----	----	----	r	----	----	----
<b>Charadiiformes</b>								
Semipalmated Plover	u	u	----	----	----	----	----	r
Killdeer	a	c	c	c	a	c	c	c
Greater Yellowlegs	c	c	c	c	u	u	c	c

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
Lesser Yellowlegs	----	u	u	u	r	----	u	u
Solitary Sandpiper	r	u	u	u	r	u	u	u
Spotted Sandpiper	u	u	c	c	u	u	c	c
Semipalmated Sandpiper	c	u	u	u	----	----	u	u
Western Sandpiper	r	r	----	u	----	----	----	----
Least Sandpiper	u	u	----	----	----	u	r	r
White-rumped Sandpiper	u	u	----	----	----	----	----	----
Pectoral Sandpiper	r	u	----	----	----	----	r	----
Dunlin	----	----	----	----	----	r	----	----
Short-billed Dowitcher	r	----	----	----	----	----	----	r
Wilson's Snipe	u	u	r	r	u	r	----	----
American Woodcock	----	----	r	----	----	----	----	----
Laughing Gull	u	----	u	u	u	----	u	u
Ring-billed Gull	a	a	a	a	a	a	a	a
Herring Gull	c	u	c	c	r	u	u	u
Lesser Black-backed Gull	r	r	----	----	----	----	----	----
Great Black-backed Gull	c	u	c	u	r	u	u	u
Caspian Tern	r	u	u	u	----	u	u	u
Forster's Tern	----	----	r	----	----	r	----	----
Least Tern	r	----	----	----	----	----	----	----
<b>Columbiformes</b>								
Rock Dove	c	u	c	c	u	u	u	u
Mourning Dove	r	u	u	u	u	u	u	u
<b>Cuculiformes</b>								
Yellow-billed Cuckoo	r	u	----	u	u	u	u	u
<b>Apodiformes</b>								
Common Nighthawk	----	----	----	----	----	----	r	----
Chimney Swift	a	a	c	c	a	a	c	c
<b>Hummingbird</b>								
Ruby-throated Hummingbird	----	u	u	u	----	u	u	u
<b>Coraciiformes</b>								
Belted Kingfisher	u	c	c	c	c	c	c	c

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
<b>Piciformes</b>								
Red-headed Woodpecker	----	----	----	----	----	----	----	r
Red-bellied Woodpecker	u	c	----	u	c	c	u	u
Yellow-bellied Sapsucker	----	----	----	----	r	u	r	r
Downy Woodpecker	c	c	c	c	c	c	c	c
Hairy Woodpecker	r	u	u	u	r	u	c	c
Northern (Yellow-shafted) Flicker	c	c	c	c	c	c	c	c
Pileated Woodpecker	r	u	u	u	r	u	u	u
<b>Passeriformes</b>								
<b>Tyrant Flycatchers</b>								
Eastern Wood-Pewee	r	u	u	u	r	u	u	u
Yellow-bellied Flycatcher	----	----	u	----	----	----	----	----
Acadian Flycatcher	----	----	----	----	----	r	r	r
Alder Flycatcher	----	----	----	----	----	----	----	r
Willow Flycatcher	----	r	----	----	----	u	u	u
Least Flycatcher	----	----	----	----	----	r	r	r
Eastern Phoebe	c	c	u	c	c	c	c	c
Great Crested Flycatcher	r	u	----	----	r	u	u	u
Eastern Kingbird	c	c	c	c	c	c	c	c
<b>Vireos</b>								
White-eyed Vireo	u	u	u	u	u	u	c	c
Warbling Vireo	u	u	u	u	u	c	c	c
Philadelphia Vireo	----	----	----	----	----	r	----	----
Red-eyed Vireo	r	u	u	u	u	u	c	c
<b>Crows - Jays</b>								
Blue Jay	c	u	c	c	c	c	c	c
American Crow	a	a	a	a	a	a	a	a
Fish Crow	a	a	a	a	a	a	a	a
<b>Lark and Swallows</b>								
Horned Lark	----	r	----	----	----	r	----	----
Purple Martin	r	r	r	----	----	----	----	----

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
Tree Swallow	c	c	c	c	c	c	c	c
Northern Rough-winged Swallow	c	c	c	c	c	c	c	c
Bank Swallow	r	----	----	----	r	----	r	u
Cliff Swallow	----	----	----	----	r	----	----	u
Barn Swallow	c	c	c	c	c	c	c	c
<b>Titmice - Chickadees</b>								
Carolina Chickadee	c	a	c	c	a	a	c	c
Black-capped Chickadee	----	----	----	----	r	----	----	----
Tufted Titmouse	u	c	u	u	c	a	c	c
White-breasted Nuthatch	----	----	----	----	----	u	u	u
Brown Creeper	----	----	----	----	r	u	----	r
<b>Wrens</b>								
Carolina Wren	a	a	c	c	a	a	c	c
House Wren	u	c	c	c	----	u	----	----
Winter Wren	----	u	r	----	----	u	u	u
Marsh Wren	----	c	c	c	u	u	----	u
<b>Kinglets and Gnatcatcher</b>								
Golden-crowned Kinglet	----	----	----	----	u	u	u	u
Ruby-crowned Kinglet	u	u	u	u	u	c	c	c
Blue-gray Gnatcatcher	u	u	c	c	u	c	c	c
<b>Thrushes</b>								
Eastern Bluebird	c	c	u	u	u	u	----	u
Gray-cheeked Thrush	----	r	----	----	----	----	r	r
Swainson's Thrush	----	u	----	----	----	u	r	r
Hermit Thrush	----	r	----	----	r	u	r	r
Wood Thrush	----	----	----	----	----	r	r	r
American Robin	c	c	c	c	a	a	c	c
<b>Mimic Thrushes</b>								
Gray Catbird	c	c	c	c	a	c	c	c
Northern Mockingbird	a	a	c	c	c	c	c	c
Brown Thrasher	u	u	u	u	u	u	u	u

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
<b>Starling and Pipit</b>								
European Starling	a	a	c	c	a	c	c	c
American Pipit	----	r	----	----	----	r	----	----
<b>Waxwings</b>								
Cedar Waxwing	u	c	u	u	u	c	u	u
<b>Wood Warblers</b>								
Tennessee Warbler	----	----	----	----	----	----	r	----
Nashville Warbler	----	----	----	----	----	r	r	r
Northern Parula	----	----	----	----	u	r	u	u
Yellow Warbler	u	c	c	c	u	u	c	c
Chestnut-sided Warbler	r	----	----	----	r	----	r	r
Magnolia Warbler	----	----	----	----	r	r	u	u
Black-throated Blue Warbler	----	----	----	----	----	u	u	u
Yellow-rumped (Myrtle) Warbler	c	u	u	u	c	c	c	c
Black-throated Green Warbler	----	----	----	----	----	r	u	u
Blackburnian Warbler	----	----	----	----	----	r	----	----
Prairie Warbler	----	----	----	----	----	r	----	----
Palm Warbler	c	u	u	u	u	u	----	u
Bay-breasted Warbler	----	r	----	----	----	----	u	u
Blackpoll Warbler	----	u	u	----	----	r	u	u
Black-and-white Warbler	----	----	----	----	r	r	u	u
American Redstart	r	r	----	----	----	r	u	u
Prothonotary Warbler	----	----	----	----	r	r	u	u
Ovenbird	----	----	----	----	----	----	r	r
Northern Waterthrush	----	u	----	----	r	r	u	u
Louisiana Waterthrush	----	----	----	----	----	r	----	----
Kentucky Warbler	----	----	----	----	----	r	----	----
Common Yellowthroat	r	u	u	u	r	c	c	c
Canada Warbler	----	----	----	----	r	----	u	u
Yellow-breasted Chat	----	----	----	----	----	----	r	r

Species	Kingman				Kenilworth			
	2001	2002	2003	2004	2001	2002	2003	2004
<b>Tanager</b>								
Scarlet Tanager	----	----	----	----	----	r	u	u
<b>Sparrow - Towhees</b>								
Eastern Towhee	----	r	----	----	u	u	u	u
American Tree Sparrow	u	u	u	u	----	u	----	u
Chipping Sparrow	----	----	u	u	----	----	u	u
Field Sparrow	u	u	----	----	u	r	u	u
Savannah Sparrow	----	r	----	----	----	----	r	r
Fox Sparrow	u	u	r	u	----	u	----	u
Song Sparrow	a	a	a	a	a	a	a	a
Swamp Sparrow	u	u	u	u	u	u	c	c
White-throated Sparrow	a	c	c	c	a	c	c	c
White-crowned Sparrow	----	r	----	----	----	----	----	----
Dark-eyed Junco	u	u	u	u	----	u	u	u
<b>Cardinals - Grosbeaks</b>								
Northern Cardinal	a	a	a	a	a	a	a	a
Rose-breasted Grosbeak	----	----	----	----	----	r	u	u
Blue Grosbeak	u	u	u	u	u	u	u	u
Indigo Bunting	u	c	c	c	u	c	c	c
<b>Blackbirds - Orioles</b>								
Bobolink	----	r	----	----	----	----	u	u
Red-winged Blackbird	a	a	a	a	a	a	a	a
Eastern Meadowlark	----	----	----	----	----	----	----	r
Rusty Blackbird	----	----	----	----	u	u	----	u
Common Grackle	c	c	c	c	c	c	c	c
Brown-headed Cowbird	c	c	u	u	u	u	u	u
Orchard Oriole	u	u	u	u	u	c	u	u
Baltimore Oriole	u	u	u	u	u	u	u	u
<b>Finches</b>								
House Finch	c	c	u	u	u	u	u	u
American Goldfinch	a	c	c	c	c	c	c	c
House Sparrow	u	u	u	u	----	u	----	u

**Table 2: Wetland users**

Total abundances (total counts) of *wetland user* species for all observations (point counts and between point observations) made during the four-year study. Bird habitat was defined according to Illiff, 1996 and thus does not include several mudflat/wet-field species. Some of the same birds were likely recounted. Birds are listed in alphabetical order.

<b>Species</b>	<b>Kingman</b>	<b>Kenilworth</b>
American Coot	0	1
American Green-winged Teal	209	63
American Tree Sparrow	12	0
American Wigeon	0	2
Black-crowned Night-Heron	19	0
Blue-winged Teal	2	8
Bobolink	1	38
Canada Goose	35988	9323
Common Yellowthroat	29	167
Dunlin	0	3
Glossy Ibis	1	0
Great Egret	427	173
Great Blue Heron	928	17
Greater Yellowlegs	245	57
Hooded Merganser	79	92
Least Sandpiper	83	16
Lesser Yellowlegs	28	10
.OLittle Blue Heron	2	3
Mallard	3087	2393
Marsh Wren	35	9
Pectoral Sandpiper	13	2
Pied-billed Grebe	1	0
Northern Harrier	3	4
Northern Pintail	26	21
Northern Shoveler	0	1
Red-winged Blackbird	977	2708
Ring-necked Duck	0	4
Rusty Blackbird	0	26
Snow Goose	3	0
Snowy Egret	0	5
Sora	0	1
Solitary Sandpiper	40	21
Song Sparrow	1747	691
Swamp Sparrow	36	53
Wilson's Snipe	0	3
Wood Duck	54	273

Table 3. Additive counts of Canada Goose at Kingman and Kenilworth Marshes. Many of the geese counted may be the same ones. However, the relative numbers for the seasons and years between the sites are relevant.

a. **Kingman** goose counts

<b>YEAR</b>	Winter	Spring	Summer	Fall	<b>TOTAL</b>
2001	2857	2828	2073	1840	<b>9598</b>
2002	2915	2842	2822	1910	<b>10489</b>
2003	3595	1965	1736	1506	<b>8802</b>
2004	3505	1899	1655	1461	<b>8520</b>
<b>Average</b>	<b>3219</b>	<b>2384</b>	<b>2072</b>	<b>1679</b>	

b. **Kenilworth** goose counts

<b>YEAR</b>	Winter	Spring	Summer	Fall	<b>TOTAL</b>
2001	918	220	533	1225	<b>2896</b>
2002	1110	508	195	332	<b>2145</b>
2003	321	371	278	906	<b>1876</b>
2004	299	341	273	854	<b>1769</b>
<b>Average</b>	<b>662</b>	<b>360</b>	<b>320</b>	<b>829</b>	

**Table 4: Mudflat and shore users**

Total abundances of mudflat user species for all observations (point counts and between points) made during the four-year study. Some of the same birds were likely recounted. Birds are listed in alphabetical order.

<b>Species</b>	<b>Kingman</b>	<b>Kenilworth</b>
American Pipit	<b>6</b>	2
Caspian Tern	<b>8</b>	3
Dunlin	0	<b>3</b>
Greater Yellowlegs	<b>245</b>	57
Herring Gull	<b>181</b>	29
Killdeer	<b>750</b>	583
Laughing Gull	<b>206</b>	92
Least Sandpiper	<b>83</b>	16
Lesser Black-backed Gull	<b>5</b>	0
Lesser Yellowlegs	<b>28</b>	10
Pectoral Sandpiper	<b>13</b>	<b>2</b>
Ring-billed Gull	<b>7465</b>	3788
Semipalmated Sandpiper	<b>14</b>	0
Solitary Sandpiper	<b>40</b>	21
Western Sandpiper	<b>2</b>	0
White-rumped Sandpiper	<b>8</b>	0
Wilson's Snipe	0	<b>3</b>

**Table 5. Wetland users observed at Kingman and Kenilworth before and after reconstruction.** Because of differences in surveyors, survey methods, and exact survey locations between pre- and post-reconstruction surveys, this table provides presence/absence data only. The terms pre- and post-reconstruction refer to Kingman only, since \*\*Kenilworth was reconstructed in 1993. Pre-reconstruction data were collected by USGS (Dawson and Gough, unpublished, 2001), and consisted of both 10-minute point-count data and water bird surveys. Post-reconstruction data were collected by Mary Paul (USGS) during the course of this study, and consisted of weekly 5-minute point count data and walk-throughs between points. Species observed during the 5-minute point counts and therefore contributing to the post-reconstruction statistical analyses are denoted with a single\*. The habitat key is located at the end of the table. The habitats for each species are listed in decreasing order of preference; breeding habitats are capitalized. Birds are listed in alphabetical order.

Species	<sup>x</sup> Habitats	1999-2000		2001-2004	
		Pre-reconstruction Kingman	**Kenilworth	Post-reconstruction Kingman	Kenilworth
Acadian Flycatcher	BD				X
American Black Duck *	SERlj	X	X	X	X
American Coot	reF				X
American Green-winged Teal *	Fsrl	X	X	X	X
American Pipit *	msct			X	X
American Redstart	BDw	X		X	X
American Robin *	GWbc			X	X
American Tree Sparrow *	awfg			X	
American Wigeon	rfl				X
American Woodcock	BW			X	
Bald Eagle *	ERv	X		X	X
Baltimore Oriole *	BGW	X	X	X	X
Bank Swallow *	Rec	X		X	X
Barn Swallow *	Gera	X		X	X
Belted Kingfisher *	RE	X	X	X	X
Black and White Warbler	DKB				X
Blackburnian Warbler	dbNw				X
Black-crowned Night-Heron *	sErf	X		X	
Blackpoll Warbler *	dwbk	X	X	X	X
Blue-gray Gnatcatcher *	BDw	X	X	X	X
Blue-throated Blue Warbler	Dbn	X			X
Blue-winged Teal *	Frsl	X		X	X
Bobolink *	Hf			X	X
Brown Creeper	BDk				X
Brown-headed Cowbird *	DWBKc	X	X	X	X
Bufflehead	erl	X	X		
Canada Goose *	eRFm	X	X	X	X
Canada Warbler *	bDXN				X
Canvasback *	er			X	

**Table 5 (Cont.)**

		1999-2000		2001-2004	
		Pre-reconstruction		Post-reconstruction	
Species	Habitats	Kingman	Kenilworth	Kingman	Kenilworth
Carolina Chickadee *	DKWGB		X	X	X
Carolina Wren *	WGB	X	X	X	X
Caspian Tern *	eotr	X		X	X
Cedar Waxwing *	WBGD	X	X	X	X
Chestnut-sided Warbler	WDb			X	X
Chimney Swift *	Ugr	X	X	X	X
Cliff Swallow *	Rge				X
Common Merganser *	r			X	X
Common Snipe *	fmsr	X	X	X	X
Common Yellowthroat *	FW	X	X	X	X
Double-crested Cormorant *	Eor	X	X	X	X
Downy Woodpecker *	BDW	X		X	X
Dunlin *	stoqmf	X			X
Eastern Phoebe *	RGw			X	X
Eastern Tufted Titmouse *	BDW GK	X	X	X	X
Eastern Wood-Pewee *	DBwk	X		X	X
Fish Crow *	wesKDzm	X	X	X	X
Forster's Tern *	eSoir	X	X	X	X
Fox Sparrow *	wkb			X	X
Glossy Ibis	sfErm			X	
Golden-crowned Kinglet	kdbwN				X
Gray Catbird *	WGB	X	X	X	X
Gray-cheeked Thrush	dbw		X	X	X
Great Black-backed Gull *	eoziSp	X		X	X
Great Blue Heron *	rfEsB	X	X	X	X
Great Crested Flycatcher *	BDkW		X	X	X
Great Egret *	sfrE	X	X	X	X
Greater Yellowlegs *	sfqtrm	X	X	X	X
Green Heron *	rBEs	X	X	X	X
Hairy Woodpecker *	BD		X	X	X
Hermit Thrush *	bkNXD			X	X
Herring Gull *	eoziSrmP	X		X	X
Hooded Merganser *	rsFb	X	X	X	X
Hooded Warbler	DB		X		
Horned Lark	MO				X
Kentucky Warbler	BD				X
Killdeer *	MWCQ	X	X	X	X
Laughing Gull *	emzoSl	X	X	X	X

**Table 5 (Cont.)**

		1999-2000		2001-2004	
		Pre-reconstruction		Post-reconstruction	
Species	Habitats	Kingman	Kenilworth	Kingman	Kenilworth
Least Sandpiper *	rtqfsm	X	X	X	X
Least Tern *	EO			X	
Lesser Black-backed Gull *	zeloprm	X		X	
Lesser Yellowlegs *	sfqtrm	X	X	X	X
Little Blue Heron *	sfEr		X	X	X
Louisiana Waterthrush	B				X
Magnolia Warbler *	wdbNX				X
Mallard *	REFs	X	X	X	X
Marsh Wren *	FS			X	X
Myrtle Warbler	wkbD	X			
Nashville Warbler *	wbX			X	X
Northern Harrier *	sfhAv			X	X
Northern Parula *	Bwd	X	X	X	X
Northern Pintail *	freSl	X	X	X	X
Northern Rough-winged Swallow *	Rec	X	X	X	X
Northern Shoveler *	Frsl				X
Northern Waterthrush *	bwX	X	X	X	X
Osprey *	Erv	X	X	X	X
Ovenbird	DKB				X
Pectoral Sandpiper *	frqms	X		X	X
Philadelphia Vireo	wb				X
Pied-billed Grebe *	ReF	X		X	
Pileated Woodpecker *	BDK			X	X
Prothonotary Warbler *	B		X		X
Purple Martin *	Gre		X	X	
Red-bellied Woodpecker *	BDw		X	X	X
Red-eyed Vireo *	DBw	X	X	X	X
Red-shouldered Hawk *	Bwv	X	X	X	X
Red-winged Blackbird *	FSHAm	X	X	X	X
Ring-billed Gull *	emzolru	X	X	X	X
Ring-necked Duck *	rfe				X
Rock Dove *	Ugm			X	X
Rose-breasted Grosbeak *	Dwb				X
Ruby-crowned Kinglet *	wbkD			X	X
Ruby-throated Hummingbird *	BGW		X	X	X
Ruddy Duck	Re	X			
Rusty Blackbird *	bf				X
Savannah Sparrow *	CHaOm			X	X

**Table 5 (Cont.)**

		1999-2000		2001-2004	
		Pre-reconstruction		Post-reconstruction	
Species	Habitats	Kingman	Kenilworth	Kingman	Kenilworth
Scarlet Tanager *	BD	X	X		X
Semipalmated Plover *	toqr	X		X	
Semipalmated Sandpiper *	tosq	X		X	X
Snow Goose hybrid *	msef			X	
Snowy Egret *	sfEr				X
Solitary Sandpiper *	rfm	X	X	X	X
Song Sparrow *	GAWF	X		X	X
Sora *	Fs				X
Spotted Sandpiper *	Rq	X	X	X	X
Stilt Sandpiper		X			
Swainson's Thrush *	dbNw		X	X	X
Swamp Sparrow *	Fxsa			X	X
Tennessee Warbler	wdb				X
Tree Swallow *	rSAe		X	X	X
Tricolored Heron	sEr				X
Veery	Db		X		
Warbling Vireo *	BW	X		X	X
Western Sandpiper *	tosq			X	
White-breasted Nuthatch *	DBw				X
White-eyed Vireo *	WB			X	X
White-rumped Sandpiper *	tqmo			X	
White-throated Sparrow *	wgb			X	X
Winter Wren *	bdN			X	X
Wood Duck *	Brfl		X	X	X
Wood Thrush	DB				X
Yellow Palm Warbler *	wbd			X	X
Yellow-bellied Flycatcher	bdwn			X	
Yellow-bellied Sapsucker *	dbNX				X
Yellow-billed Cuckoo *	BDW	X		X	X
Yellow-shafted Flicker *	WGBDa	X		X	X

<sup>x</sup> Habitat codes according to Illif et al. 1996. Breeding habitats are capitalized.

a Abandoned fields; b Bottomlands; c Pastures; d Upland deciduous forests; e Estuaries; f Fresh marshes; g Gardens, ag lands; h Hayfields; i Jetties; k Pine woods; l littoral zone; m Muddy fields; n Northern conifers; o Ocean beaches, sand flats; p Pelagic zone (ocean beyond 3 miles); r Reservoirs, rivers, ponds; s Salt marshes; t Tidal mud flats; u Urban areas; v Hawk migration corridors; w Wood edge, hedgerows, scrub; x Bogs; z Sanitary landfills

**Table 6. Frequencies and abundances of bird species at Kingman and Kenilworth during 2003.**

The Second Maryland/DC Breeding Bird Atlas Project Handbook, produced by the Maryland Ornithological Society, was used during species identification. The seasonal time periods have been defined as follows: Winter (W) = Dec-Feb; Spring (Sp) = Mar-May; Summer (Su) = Jun-Aug; Fall (F) = Sep-Nov. \* Represents the annual sum of observations, including repeat observations of the same birds.

Common Name	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Cormorant</b>										
Double-crested Cormorant	18	12	23	7	6	10	0	73	21	21
<b>Herons &amp; Egret</b>										
Great Blue Heron	39	32	41	10	12	11	8	178	75	6
Great Egret	16	13	16	0	8	8	0	75	43	7
Snowy Egret	0	1	1	1	0	0	0	0	1	1
Little Blue Heron	1	0	1	0	1	0	0	1	0	1
Green Heron	6	4	7	1	6	0	0	6	4	1
Black-crowned Night-Heron	6	0	6	1	5	0	0	6	0	1
<b>Vultures</b>										
Black Vulture	0	4	4	1	0	3	0	0	6	3
Turkey Vulture	7	5	12	7	2	1	2	9	8	3
<b>Ducks &amp; Geese</b>										
Canada Goose	40	32	42	11	12	11	8	8802	1876	561
Wood Duck	3	25	26	9	7	9	1	18	75	9
American Black Duck	1	16	17	4	2	7	4	2	63	5
Mallard	41	38	42	11	12	11	8	576	579	42
Blue-winged Teal	0	2	2	0	0	2	0	0	4	3
Northern Pintail	0	2	2	0	0	1	1	0	8	7
American Green-winged Teal	5	1	6	5	0	0	1	21	3	9
Canvasback	1	0	1	1	0	0	0	1	0	1
Ring-necked Duck	1	0	1	0	0	0	1	2	0	2
Hooded Merganser	9	4	10	3	0	0	7	54	22	11
Common Merganser	6	4	8	3	0	0	5	48	45	17
domestic white duck	12	0	12	6	2	2	2	12	0	1

Table 6. (Cont.)

Common Name	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Hawks</b>										
Osprey	10	9	12	7	3	2	0	13	20	2
Bald Eagle	10	8	17	4	6	4	3	10	9	2
Northern Harrier	0	2	2	0	0	2	0	0	2	1
Sharp-shinned Hawk	3	2	4	0	1	3	0	3	2	1
Cooper's Hawk	5	2	6	0	0	3	3	7	3	2
Red-shouldered Hawk	17	23	27	10	4	7	6	19	42	4
Red-tailed Hawk	8	6	11	4	0	3	5	9	8	2
American Kestrel	0	4	4	0	1	3	0	0	5	2
<b>Plovers</b>										
Killdeer	15	18	26	7	6	6	7	97	115	20
<b>Sandpipers</b>										
Greater Yellowlegs	12	9	14	2	5	7	0	71	19	12
Lesser Yellowlegs	2	1	3	3	0	0	0	2	3	3
Solitary Sandpiper	2	2	4	2	2	0	0	2	12	4
Spotted Sandpiper	7	6	10	3	4	3	0	13	13	3
Semipalmated Sandpiper	6	2	7	1	5	1	0	50	3	13
Least Sandpiper	0	1	1	0	0	1	0	0	3	3
Pectoral Sandpiper	0	1	1	0	0	1	0	0	1	1
Common Snipe	1	0	1	1	0	0	0	1	0	1
American Woodcock	1	0	1	1	0	0	0	1	0	1
<b>Gulls &amp; Terns</b>										
Laughing Gull	5	2	5	0	2	3	0	58	4	20
Ring-billed Gull	35	26	35	9	8	10	8	1688	706	131
Herring Gull	10	4	12	3	0	2	7	78	5	49
Great Black-backed Gull	14	6	16	4	0	4	8	77	9	8
Caspian Tern	3	1	3	2	1	0	0	3	1	1
Forster's Tern	1	0	1	0	1	0	0	1	0	1

Table 6 (Cont.)

Common Name	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Doves</b>										
Rock Dove	9	3	12	2	3	6	1	104	4	40
Mourning Dove	7	6	11	2	4	5	0	14	6	5
<b>Cuckoo</b>										
Yellow-billed Cuckoo	0	7	7	3	4	0	0	0	17	1
<b>Nightjars &amp; Swift</b>										
Common Nighthawk	0	2	2	1	0	1	0	0	3	1
Chimney Swift	13	17	18	4	11	3	0	125	293	57
<b>Hummingbird &amp; Kingfisher</b>										
Ruby-throated Hummingbird	1	1	1	0	1	0	0	1	1	1
Belted Kingfisher	13	28	32	7	7	10	8	17	52	2
<b>Woodpeckers</b>										
Red-headed Woodpecker	0	1	1	0	0	0	1	0	1	1
Red-bellied Woodpecker	14	28	32	9	6	9	8	23	71	3
Yellow-bellied Sapsucker	0	1	1	0	0	0	1	0	1	1
Downy Woodpecker	15	34	37	11	9	9	8	21	80	3
Hairy Woodpecker	2	14	16	5	3	4	4	3	16	1
Northern (Yellow-shafted) Flicker	21	23	33	7	10	9	7	40	47	5
Pileated Woodpecker	4	2	6	3	0	0	1	4	2	1
<b>Flycatchers</b>										
Eastern Wood-Pewee	1	2	3	2	0	1	0	1	2	1
Yellow-bellied Flycatcher	1	0	1	1	0	0	0	1	0	1
Acadian Flycatcher	0	1	1	1	0	0	0	0	1	1
Willow Flycatcher	0	3	3	1	2	0	0	0	3	1
Least Flycatcher	0	1	1	1	0	0	0	0	1	1
Eastern Phoebe	5	12	17	6	7	4	0	5	16	2
Great Crested Flycatcher	0	2	2	2	0	0	0	0	3	1
Eastern Kingbird	8	10	13	3	9	1	0	16	15	3

Table 6 (Cont.)

	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
Common Name	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Vireos</b>										
White-eyed Vireo	2	5	6	3	2	1	0	2	8	1
Warbling Vireo	1	8	8	3	5	0	0	2	19	3
Red-eyed Vireo	2	14	14	4	10	0	0	2	36	5
<b>Jays &amp; Crows</b>										
Blue Jay	7	10	14	5	0	8	1	33	97	12
Crow sp.								737	435	75
American Crow	29	24	37	11	8	11	7	268	263	100
Fish Crow	35	27	36	11	12	6	8	548	206	60
<b>Lark and Swallows</b>										
Purple Martin	1	0	1	1	0	0	0	1	0	1
Tree Swallow	13	14	16	8	8	0	0	85	83	9
Northern Rough-winged Swallow	11	10	13	6	7	0	0	46	29	5
Bank Swallow	0	1	1	1	0	0	0	0	1	1
Barn Swallow	15	15	18	5	12	1	0	89	82	29
<b>Chickadee, Titmouse, Nuthatch &amp; Creeper</b>										
Carolina Chickadee	13	29	32	10	9	5	8	23	70	4
Tufted Titmouse	2	21	23	10	7	1	5	2	31	4
White-breasted Nuthatch	0	2	2	0	1	1	0	0	2	1
<b>Wrens</b>										
Carolina Wren	18	40	41	11	11	11	8	49	128	5
House Wren	13	0	13	3	10	0	0	21	0	2
Winter Wren	1	4	5	0	0	2	3	2	6	1
Marsh Wren	9	0	9	0	9	0	0	12	0	2
<b>Kinglets &amp; Gnatcatcher</b>										
Golden-crowned Kinglet	0	2	2	2	0	0	0	0	4	2
Ruby-crowned Kinglet	4	8	12	4	0	3	5	7	14	2
Blue-gray Gnatcatcher	10	16	16	7	9	0	0	17	72	5

Table 6 (Cont.)

Common Name	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Thrushes</b>										
Eastern Bluebird	3	0	3	2	0	0	1	3	0	1
Gray-cheeked Thrush	0	1	1	1	0	0	0	0	1	1
Swainson's Thrush	0	2	2	2	0	0	0	0	5	2
Hermit Thrush	0	2	2	1	0	0	1	0	2	1
Wood Thrush	0	1	1	1	0	0	0	0	1	1
American Robin	13	19	23	1	9	8	5	299	157	200
<b>Mimids</b>										
Gray Catbird	12	21	21	4	9	8	0	37	85	8
Northern Mockingbird	25	23	29	3	7	11	8	132	53	14
Brown Thrasher	3	4	6	0	6	0	0	3	7	3
<b>Starling, Pipit, &amp; Waxwing</b>										
European Starling	33	18	36	9	12	10	5	1137	409	110
Cedar Waxwing	6	5	11	2	2	4	3	231	23	100
<b>Wood Warblers</b>										
Tennessee Warbler	0	1	1	0	0	1	0	0	1	1
Nashville Warbler	0	2	2	2	0	0	0	0	3	1
Northern Parula	0	6	6	3	3	0	0	0	12	3
Yellow Warbler	6	4	8	4	4	0	0	12	13	3
Chestnut-sided Warbler	0	1	1	1	0	0	0	0	1	1
Magnolia Warbler	0	2	2	2	0	0	0	0	6	3
Black-throated Blue Warbler	0	2	2	2	0	0	0	0	5	3
Yellow-rumped (Myrtle) Warbler	3	10	11	6	0	4	1	4	134	23
Black-throated Green Warbler	0	2	2	1	0	1	0	0	3	1
Palm Warbler	1	2	2	2	0	0	0	1	2	1
Bay-breasted Warbler	0	1	1	1	0	0	0	0	1	1
Blackpoll Warbler	1	3	4	3	0	0	0	2	36	10
Black-and-white Warbler	0	2	2	2	0	0	0	0	3	2

Table 6 (Cont.)

	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
Common Name	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Wood Warblers (Cont.)</b>										
American Redstart	0	1	1	1	0	0	0	0	2	2
Prothonotary Warbler	0	3	2	2	0	0	0	0	4	2
Ovenbird	0	1	1	1	0	0	0	0	1	1
Northern Waterthrush	0	2	2	2	0	0	0	0	2	1
Common Yellowthroat	5	15	15	4	10	1	0	8	68	4
Canada Warbler	0	2	2	2	0	0	0	0	4	1
Yellow-breasted Chat	0	1	1	1	0	0	0	0	1	1
<b>Tanager</b>										
Scarlet Tanager	0	2	2	2	0	0	0	0	9	4
<b>Sparrows</b>										
Eastern Towhee	0	2	2	1	1	0	0	0	2	
American Tree Sparrow	2	0	2	1	0	1	0	8	0	7
Chipping Sparrow	1	1	2	2	0	0	0	1	4	4
Field Sparrow	0	3	3	1	0	2	0	0	4	1
Savannah Sparrow	0	1	1	1	0	0	0	0	3	3
Fox Sparrow	1	0	1	1	0	0	0	1	0	1
Song Sparrow	37	32	39	11	11	9	8	313	166	19
Swamp Sparrow	2	10	10	1	0	3	6	4	24	4
White-throated Sparrow	19	23	24	9	0	7	8	197	304	26
Dark-eyed Junco	1	1	2	1	0	1	0	2	3	3
<b>Cardinal, Grosbeaks, Bunting</b>										
Northern Cardinal	37	42	42	11	12	11	8	174	254	6
Rose-breasted Grosbeak	0	2	2	2	0	0	0	0	2	1
Blue Grosbeak	1	2	3	2	1	0	0	1	3	1
Indigo Bunting	16	13	17	4	11	2	0	47	43	4

Table 6 (Cont.)

Common Name	Frequency							Abundance		
	Frequency- # dates observed (of 42 possible)			Seasonal Frequencies- # dates observed at Kingman and / or Kenilworth				Abundance- total counted * (12/02 - 11/03)		Maximum Daily # Observed at Kingman and Kenilworth Combined
	Kingman	Kenilworth	Kingman and / or Kenilworth	Sp (of 11)	Su (of 12)	F (of 11)	W (of 8)	Kingman	Kenilworth	
<b>Blackbirds &amp; Orioles</b>										
Bobolink	0	2	2	2	0	0	0	0	13	10
Red-winged Blackbird	21	33	34	11	12	11	0	163	1032	170
Common Grackle	14	17	19	6	12	1	0	80	105	33
Brown-headed Cowbird	7	4	7	4	3	0	0	12	24	20
Orchard Oriole	1	4	4	3	1	0	0	2	11	3
Baltimore Oriole	5	4	6	3	3	0	0	7	16	3
<b>Winter Finches</b>										
House Finch	3	5	7	3	1	2	1	11	15	6
American Goldfinch	24	17	27	6	12	6	3	92	33	6
<b>Weaver Finch</b>										
House Sparrow	6	0	6	2	4	0	0	11	0	5

**Table 7. Breeding bird documentation for Kingman and Kenilworth during 2003.**

\* Breeding bird criteria are taken from the Second Maryland / DC Breeding Bird Atlas Project Handbook, 2002 through 2006, produced by the Maryland Ornithological Society. Criteria and code definitions are located after the table.

Name	Breeding Criteria*	
	Kingman	Kenilworth
1. Great Blue Heron	Probable-T	Probable-T
2. Green Heron	Probable-T	Probable-T
3. Black-crowned Night Heron	Probable-T	
4. Turkey Vulture	Probable-T	Possible-X
5. Canada Goose	Confirmed-FL	Confirmed-FL
6. Wood Duck	Possible-X	Probable-T
7. American Black Duck	Possible-X	
8. Mallard	Confirmed-FL	Confirmed-FL
9. Osprey	Probable-T	Confirmed-NB
10. Bald Eagle	Probable-T	Probable-T
11. Sharp-shinned Hawk	Possible-X	
12. Red-shouldered Hawk	Probable-T	Probable-T
13. Red-tailed Hawk		Probable-P,T
14. American Kestrel		Possible-X
15. Killdeer	Probable-T	Probable-T
16. Rock Dove	Possible-X	
17. Mourning Dove	Probable-T	Probable-T
18. Yellow-billed Cuckoo		Probable-T
19. Chimney Swift	Probable-T	Probable-T
20. Belted Kingfisher	Probable-T	Probable-T
21. Red-bellied Woodpecker	Probable-T	Probable-T
22. Downy Woodpecker	Probable-T	Confirmed-FL
23. Hairy Woodpecker		Confirmed-FL
24. Yellow-shafted Woodpecker	Probable-T	Probable-T
25. Pileated Woodpecker	Probable-T	
26. Willow Flycatcher		Probable-T
27. Eastern Phoebe	Possible-X	Confirmed-FL
28. Eastern Kingbird	Confirmed-FL	Probable-P,T
29. White-eyed Vireo	Possible-X	Probable-T
30. Warbling Vireo		Probable-T
31. Red-eyed Vireo	Possible-X	Probable-T
32. American Crow	Confirmed-FY	Probable-T

**Table 7. (Cont.)**

Name	Breeding Criteria*	
	Kingman	Kenilworth
34. Tree Swallow	Confirmed-NY	Confirmed-NY,FL
35. Northern Rough-winged Swallow	Confirmed-FY	Confirmed-FY
36. Barn Swallow	Confirmed-FY	Probable-T
37. Carolina Chickadee	Probable-T	Confirmed-NB
38. Tufted Titmouse	Probable-T	Confirmed-FY,FL
39. White-breasted Nuthatch		Possible-X
40. Carolina Wren	Probable-A,P,T	Probable-A,P,T
41. House Wren	Probable-B	
42. Marsh Wren	Probable-T	
43. Blue-gray Gnatcatcher	Probable-T	Confirmed-FL
44. Eastern Bluebird	Possible-X	
45. American Robin	Confirmed-FL	Confirmed-FL
46. Gray Catbird	Probable-T	Probable-T
47. Northern Mockingbird	Confirmed-FL	Confirmed-FL
48. Brown Thrasher	Probable-T	Confirmed-FL
49. European Starling	Confirmed-FY,FL	Confirmed-FL
50. Cedar Waxwing	Possible-X	Possible-X
51. Northern Parula		Probable-T
52. Yellow Warbler	Probable-T	Probable-T
53. Prothonotary Warbler		Possible-X
54. Common Yellowthroat	Probable-T	Probable-T
55. Eastern Towhee		Confirmed-FL
56. Song Sparrow	Confirmed-FL	Probable-T
57. Northern Cardinal	Confirmed-FL	Probable-T
58. Blue Grosbeak	Possible-X	
59. Indigo Bunting	Probable-T	Probable-T
60. Red-winged Blackbird	Probable-T,A	Confirmed-FY
61. Common Grackle	Confirmed-FL	Confirmed-FY,FL
62. Brown-headed Cowbird	Probable-T	Probable-T
63. Orchard Oriole		Probable-T
64. Baltimore Oriole	Probable-T	Possible-X
65. House Finch	Possible-X	
66. American Goldfinch	Confirmed-FL	Probable-T
67. House Sparrow	Probable-T	

**Table 7. (Cont.)**

**BREEDING CRITERIA AND CODES \***

**POSSIBLE**

X – Species heard or seen in breeding habitat within Safe Dates.

**PROBABLE**

A – Agitated behavior or anxiety calls from adult. Parent birds respond to threats with distress calls by attacking intruders.

P – Pair observed in suitable breeding habitat within Safe Dates.

T – Territorial behavior or singing male present at same location at least 2 different days (observation separated by at least 5 days). Territoriality can be presumed from defensive encounters between individuals of the same species, or by observing a male singing from a variety of perches within a small area.

C- Courtship or copulation observed. This includes displays, courtship feeding, and birds mating.

N- Visiting probable nest site. Primarily applies to cavity nesters. This code applies when a bird is observed visiting the site repeatedly, but no further evidence is seen.

B – Nest building by wrens or excavation by woodpeckers. Both groups build dummy or roosting nests at the same time they are building a real one, but an unmated male will exhibit the same behavior.

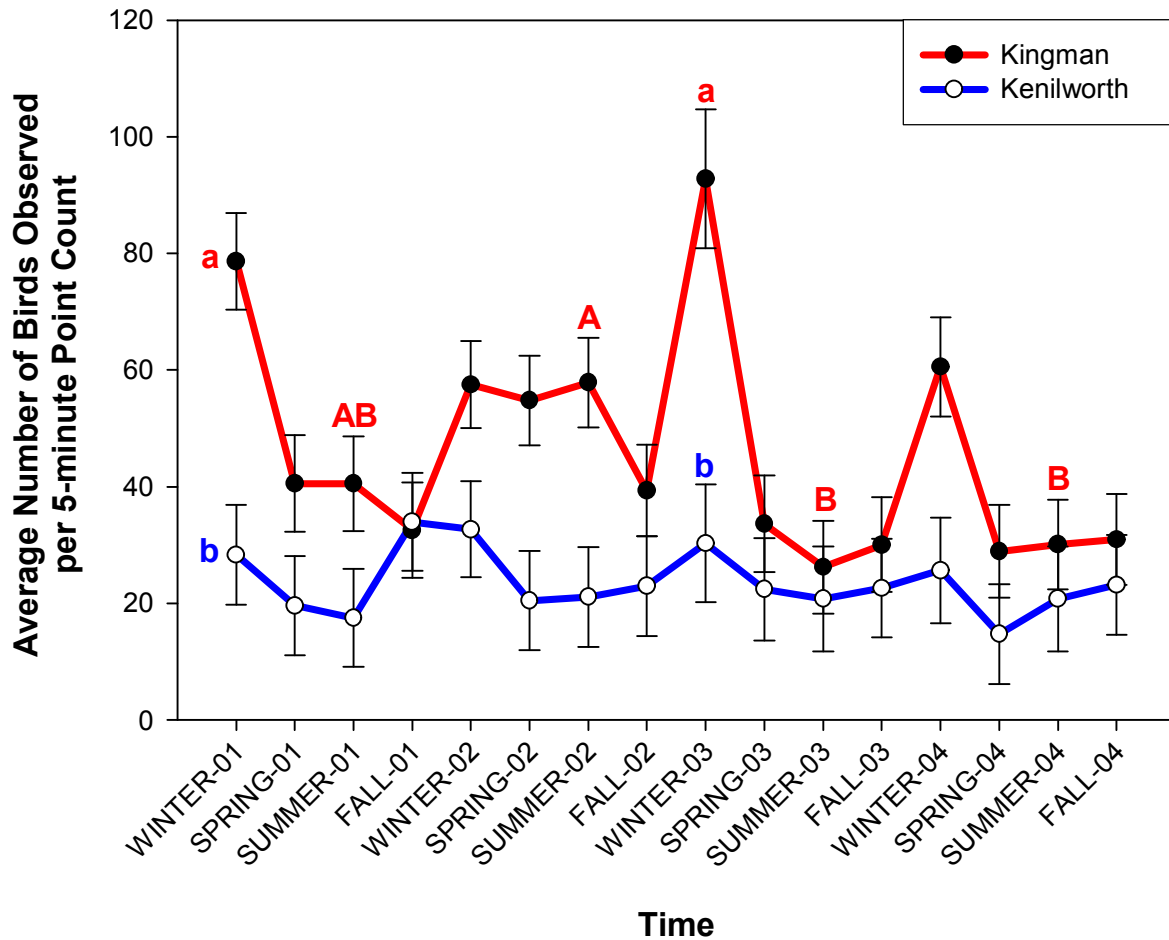
**CONFIRMED**

NB – Nest building (except wrens and woodpeckers) or adult carrying nesting material. Carrying sticks is part of the courtship ritual (code “C”) for some species.

FL – Recently fledged young or downy young. This includes dependent young only. Young cowbirds begging for food confirm both the cowbird and the host species.

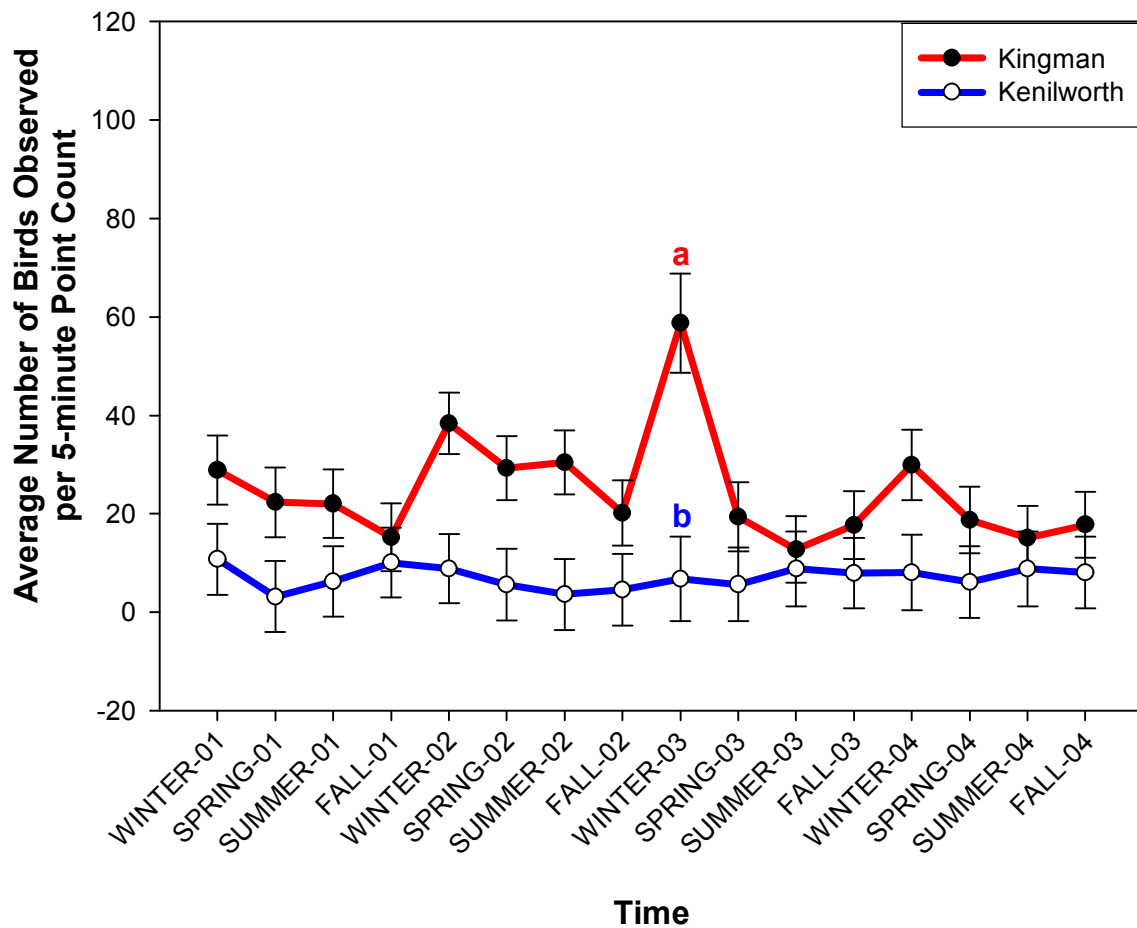
FY – Adult carrying food for young.

## FIGURES



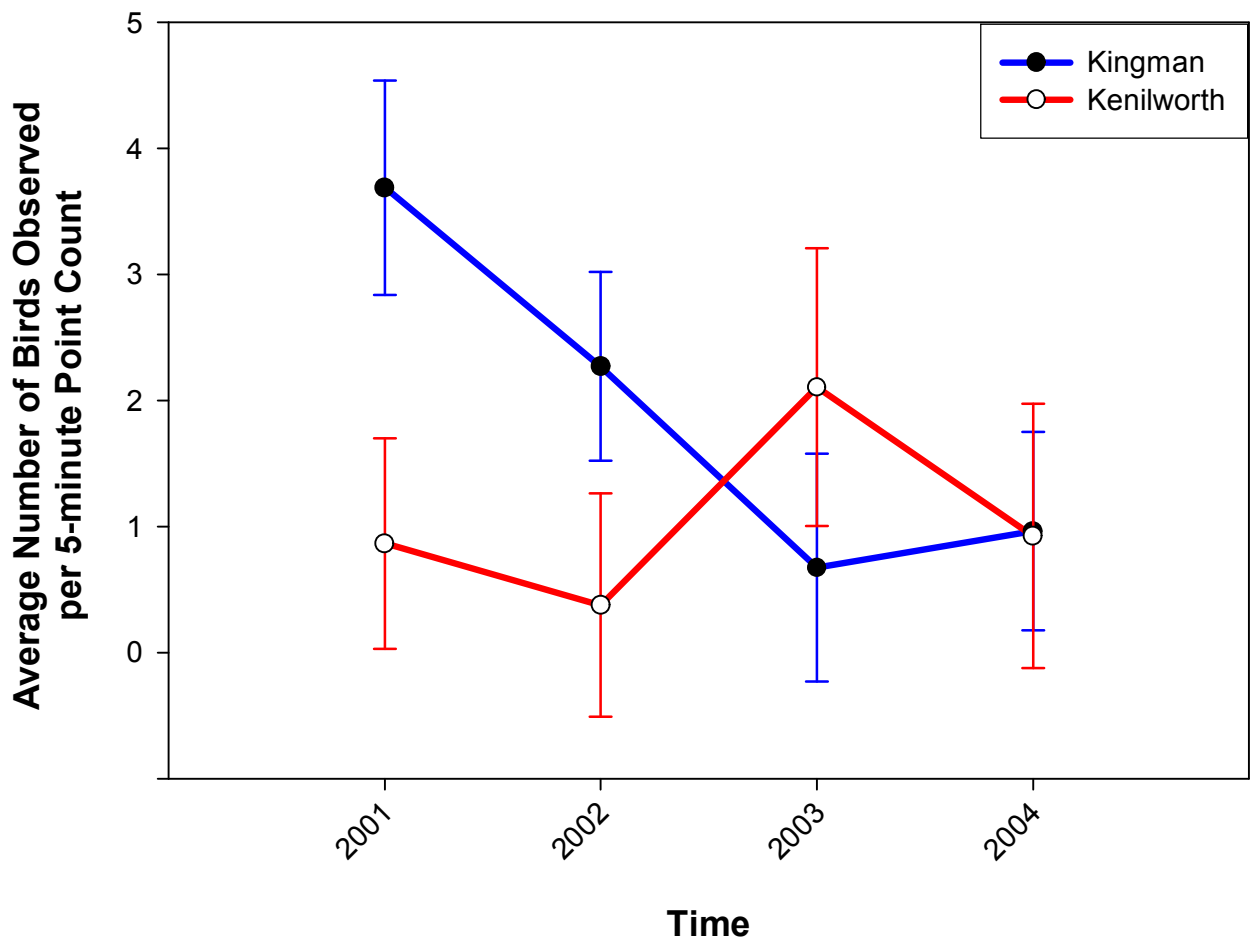
**Figure 1. Total abundances by season.**

Graph presents seasonal least square means ( $\pm 1$  SE) for total number of birds observed during one 5-minute point count. Within sites, means sharing the same upper case letters do not differ significantly among years (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). Within seasonal sampling periods, means sharing the same lower case letters do not differ significantly. Unlabeled series have no significant differences.



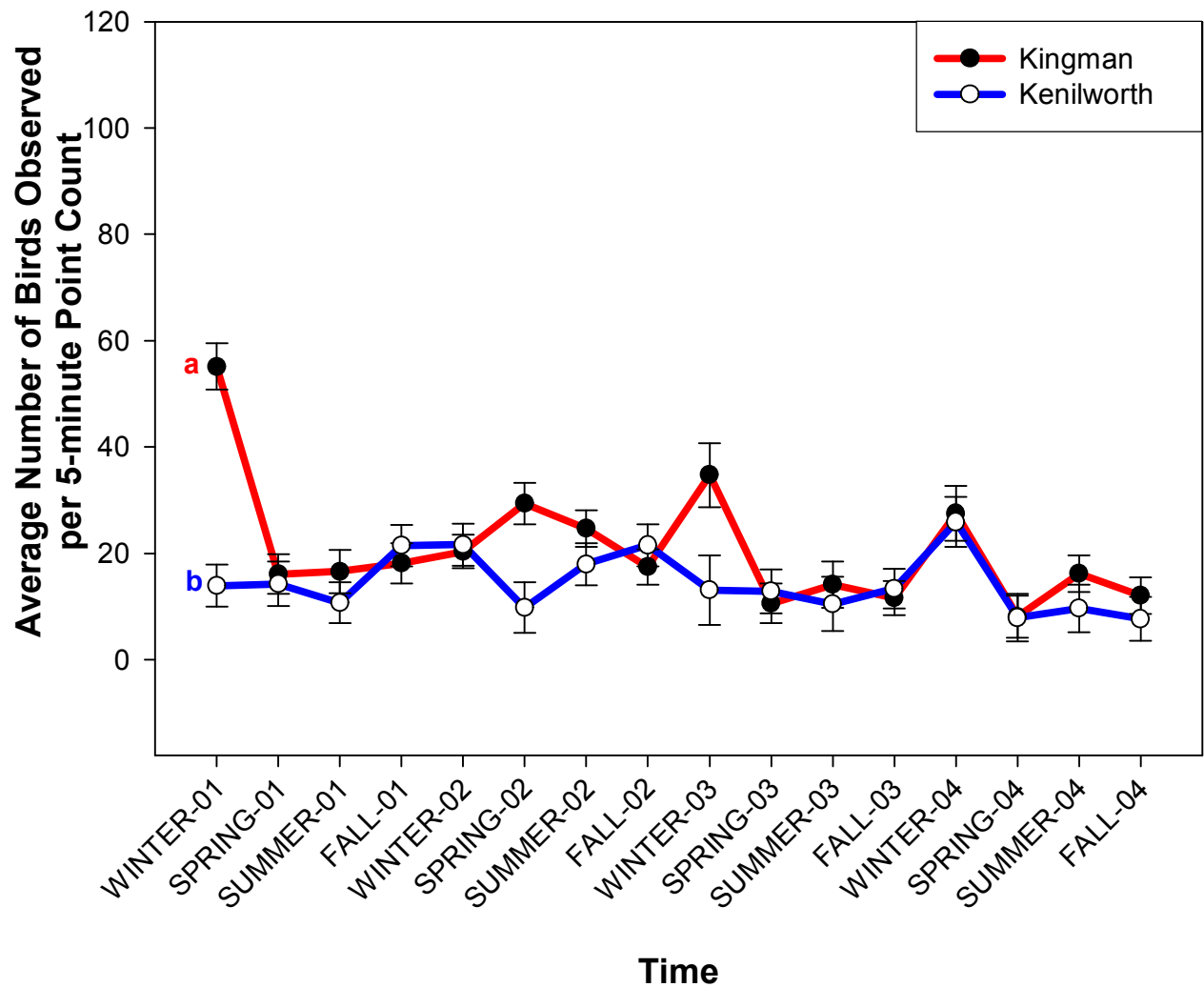
**Figure 2. Total Canada Goose Abundances by season.**

Graph presents seasonal least square means ( $\pm 1$  SE) for total number of Canada Goose observed during the 5- minute point counts. Within sites, means sharing the same upper case letters do not differ significantly among years (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). Within seasonal sampling periods, means sharing the same lower case letters do not differ significantly. Unlabeled series have no significant differences.



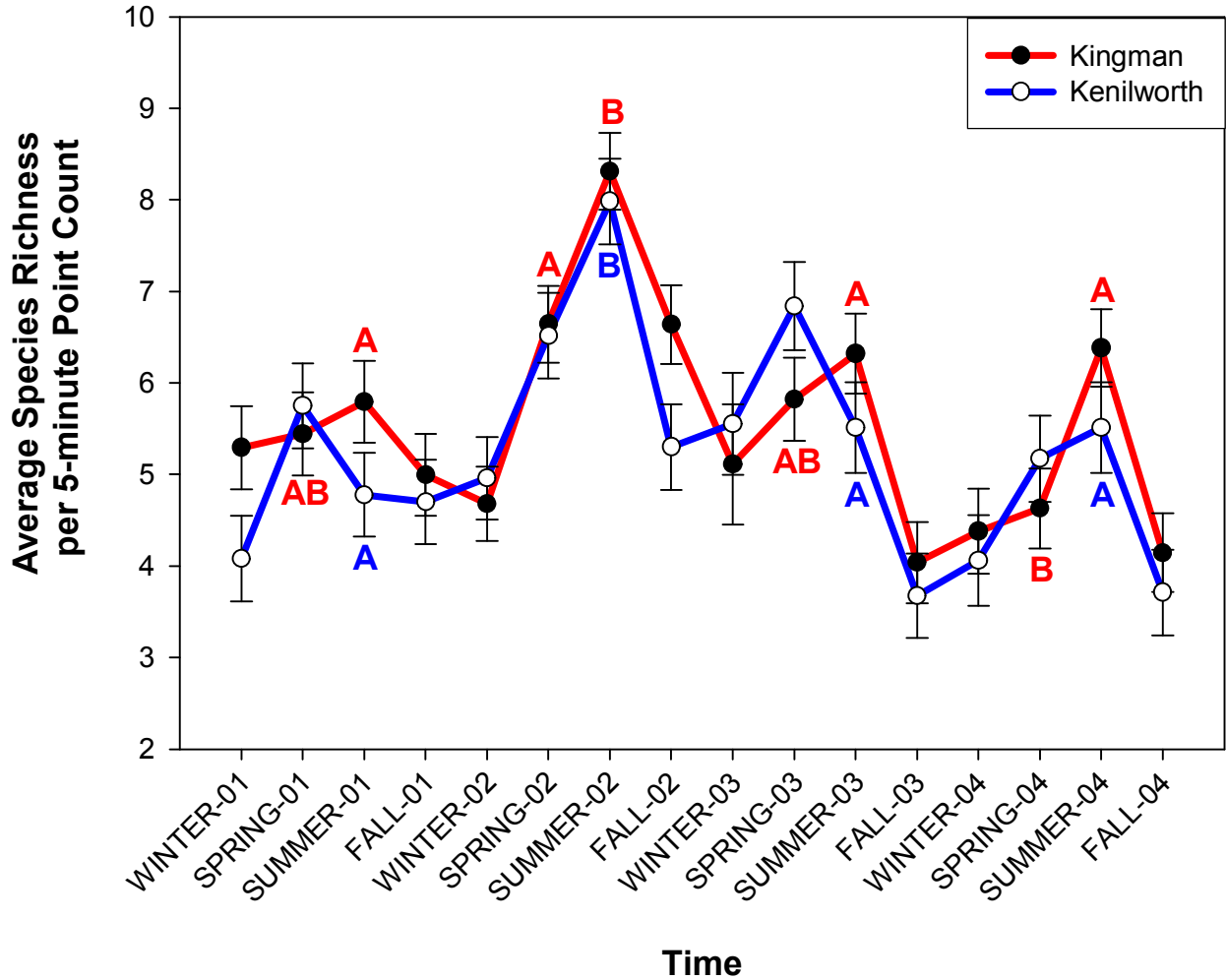
**Figure 3. Canada Goose young abundances by year.**

Graph presents annual least square means ( $\pm 1$  SE) for number of Canada Goose young observed during the weekly 5- minute point counts from the fourth week of April through the fifth week of June. No significant differences were detected between sites within the same sampling time, or between years within a given site (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ).



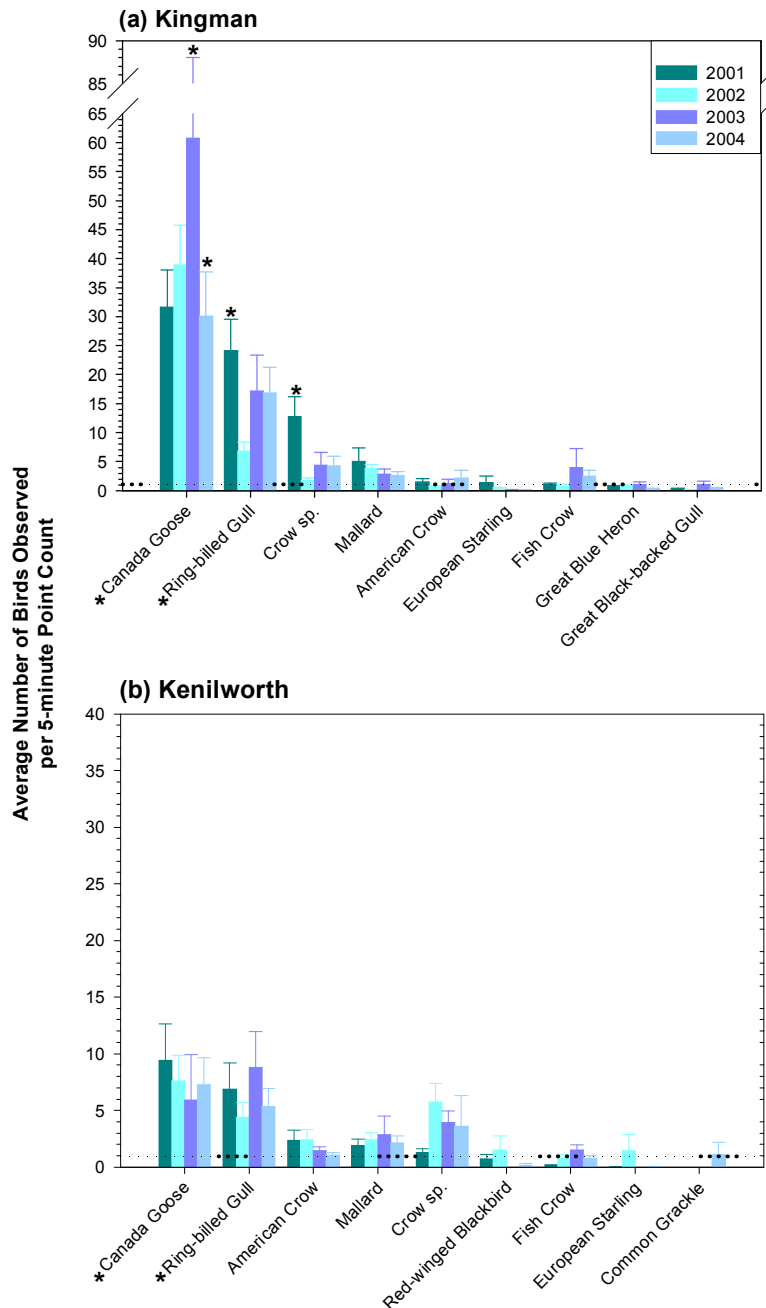
**Figure 4. Total abundances of birds excluding Canada Goose by season.**

Graph presents seasonal least square means ( $\pm 1$  SE) for total number of non- Canada Goose birds observed during the 5- minute point counts. Within sites, means sharing the same upper case letters do not differ significantly among years (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). Within seasonal sampling periods, means sharing the same lower case letters do not differ significantly. Unlabeled series have no significant differences.



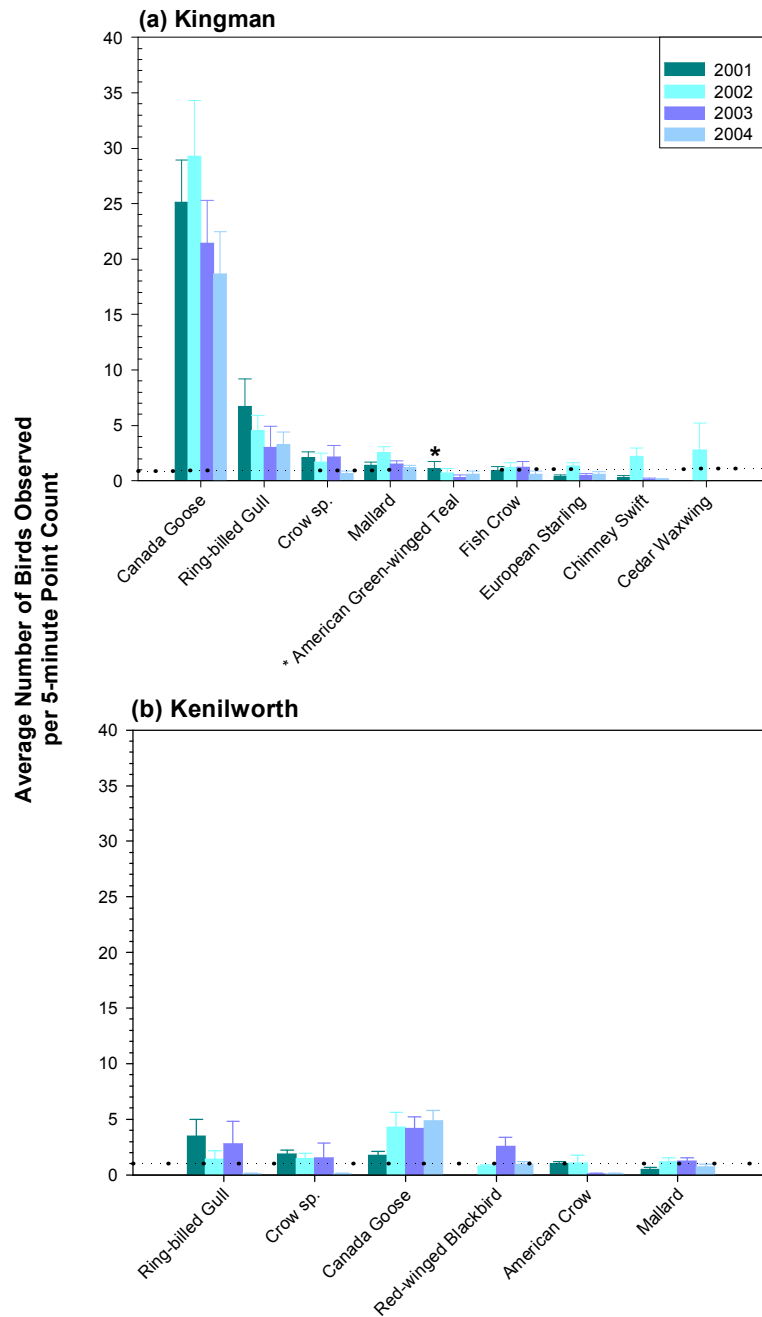
**Figure 5. Seasonal species richness.**

Graph presents seasonal least square means ( $\pm 1$  SE) for total number of bird species observed per 5-minute count. Within areas, means sharing the same upper case letters do not differ significantly among years (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). There were no significant differences among areas within seasonal sampling periods.



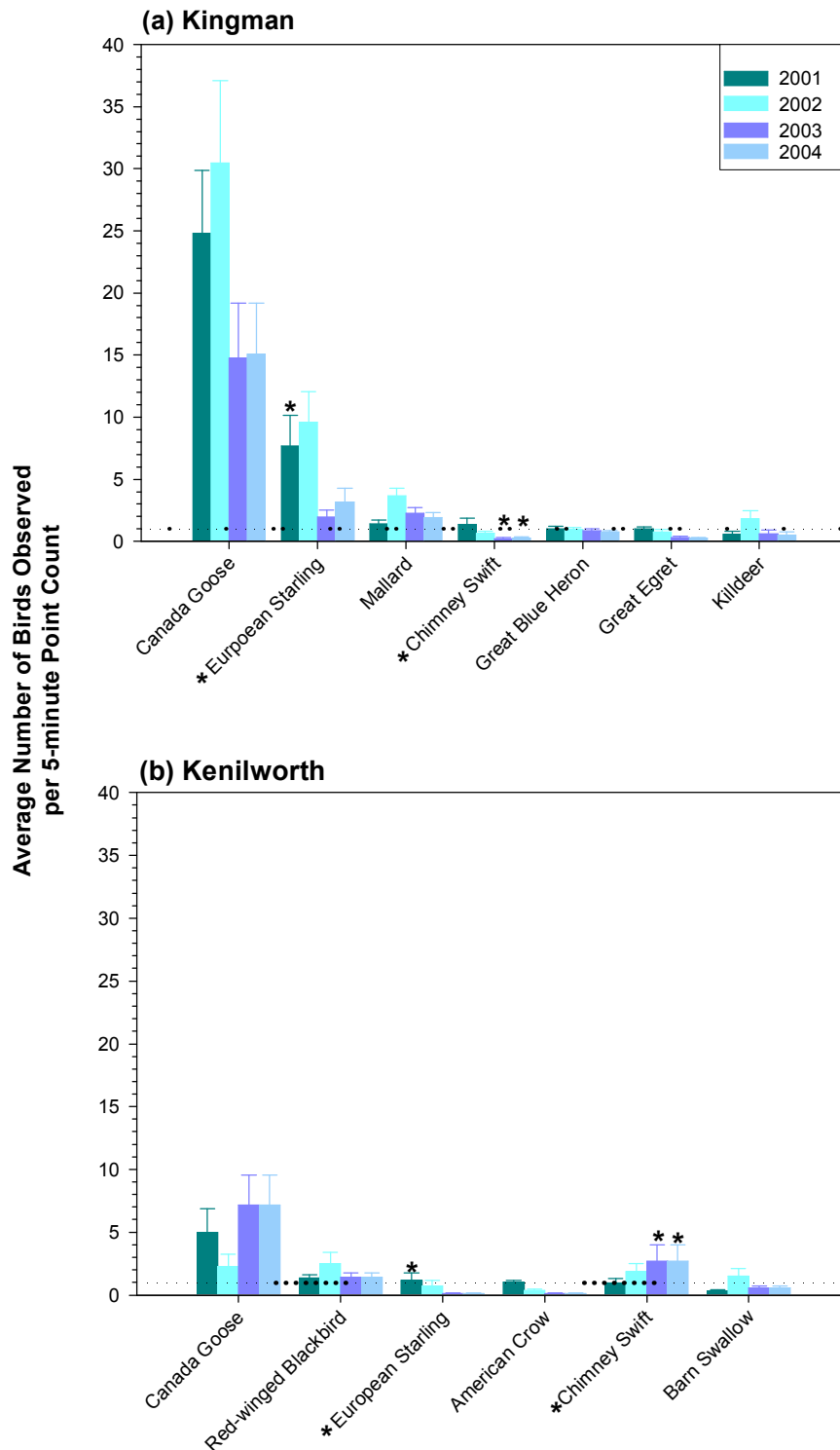
**Figure 6. Winter dominants.**

Graph presents seasonal means ( $\pm 1$  SE) for all species averaging  $\geq 1.0$  bird observed per five-minute point count at (a) Kingman and (b) Kenilworth for at least one of the four years studied. An \* associated with a bar indicates a statistically significant difference between sites for that species within that year (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). An \* associated with a species indicates a statistically significant difference between sites for that species within that season (averaged across years).



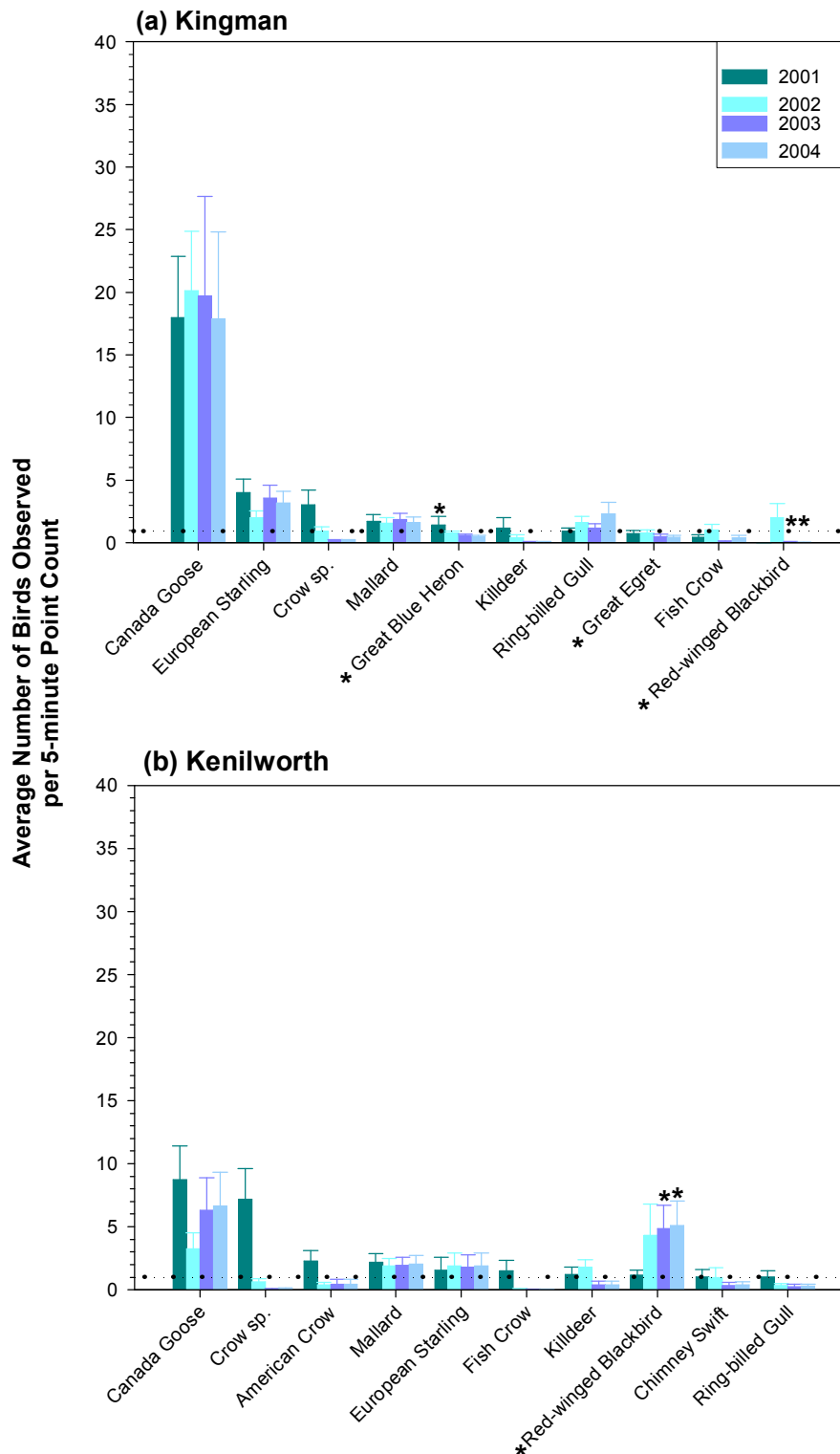
**Figure 7. Spring Dominants**

Graph presents seasonal means ( $\pm 1$  SE) for all species averaging  $\geq 1.0$  bird observed per five-minute point count at (a) Kingman and (b) Kenilworth for at least one of the four years studied. An \* associated with a bar indicates a statistically significant difference between sites for that species within that year (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). An \* associated with a species indicates a statistically significant difference between sites for that species within that season (averaged across years).



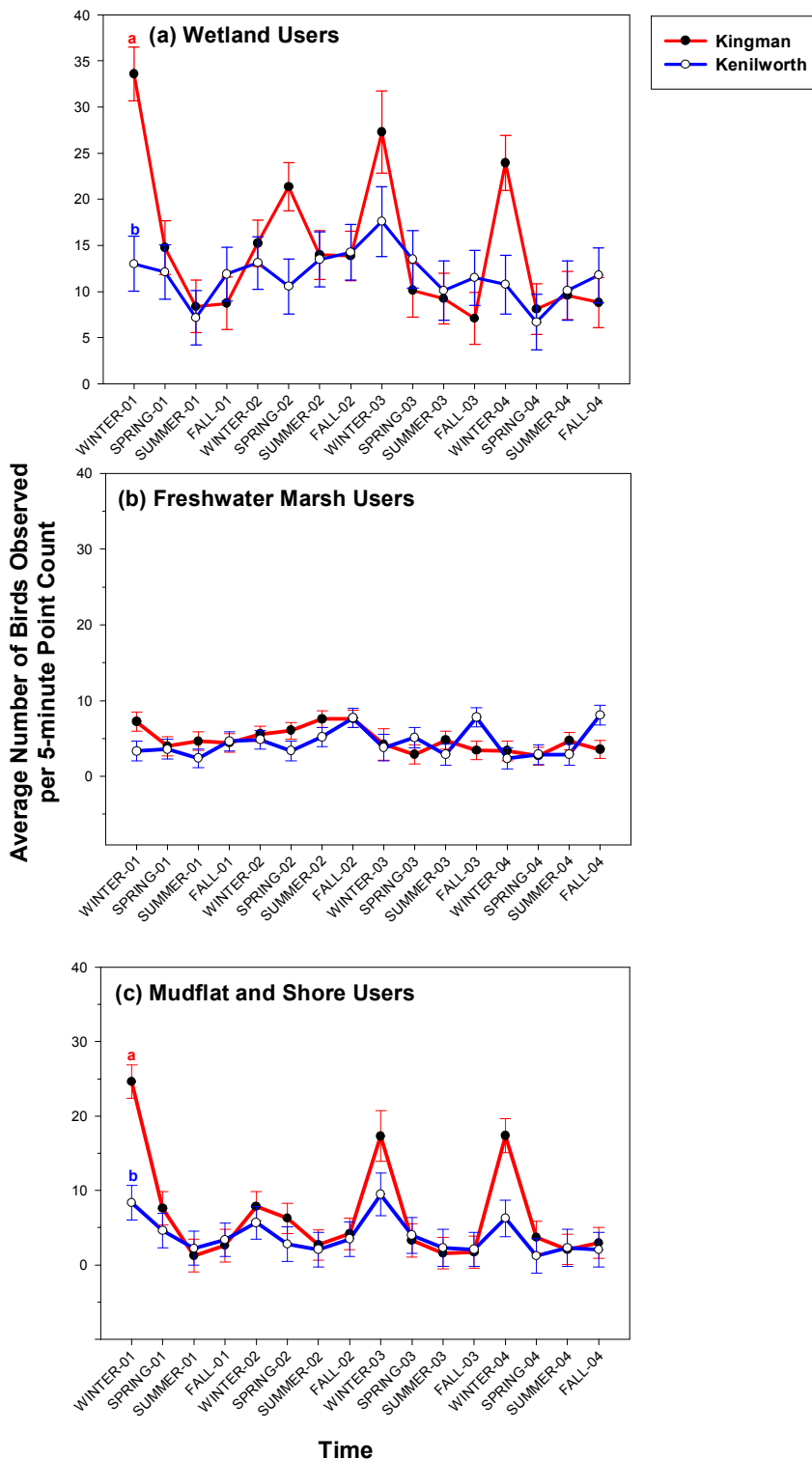
**Figure 8. Summer Dominants**

Graph presents seasonal means ( $\pm 1$  SE) for all species averaging  $\geq 1.0$  bird observed per five-minute point count at (a) Kingman and (b) Kenilworth for at least one of the four years studied. An \* associated with a bar indicates a statistically significant difference between sites for that species within that year (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). An \* associated with a species indicates a statistically significant difference between sites for that species within that season (averaged across years).



**Figure 9. Fall Dominants**

Graph presents seasonal means ( $\pm 1$  SE) for all species averaging  $\geq 1.0$  bird observed per five-minute point count at (a) Kingman and (b) Kenilworth for at least one of the four years studied. An \* associated with a bar indicates a statistically significant difference between sites for that species within that year (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). An \* associated with a species indicates a statistically significant difference between sites for that species within that season (averaged across years).



**Figure 10. User Abundances by Functional Guild and Season**

Graph presents seasonal least square means ( $\pm 1$  SE) for total number of birds characterized as a) wetland users, b) freshwater marsh users, or c) mudflat and shore users observed during one 5-minute point count at Kingman and Kenilworth. Within seasonal sampling periods, site means sharing the same lower case letters do not differ significantly (Tukey's studentized range test of least square means; overall  $\alpha = 0.05$ ). Unlabeled series have no significant differences.

**Appendix 1**  
**Repeated Measures ANOVA Tables**

### Total Abundances by Season

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.905	3.839588	0.00936
Season	3	1950.706	21.77559	7.18E-14
Year*Season	9	1948.523	1.920859	0.045053
Area	1	12.98304	6.178796	0.027335
Year*Area	3	1953.905	1.494411	0.214149
Season*Area	3	1950.706	11.35489	2.21E-07
Year*Season*Area	9	1948.523	2.560189	0.006315

### Total Canada Goose Abundances by season

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.909	1.059709	0.36508
Season	3	1950.649	7.330735	6.93E-05
Year*Season	9	1948.433	0.683981	0.724093
Area	1	12.73156	5.439055	0.036795
Year*Area	3	1953.909	2.45001	0.061867
Season*Area	3	1950.649	5.503688	0.000919
Year*Season*Area	9	1948.433	1.203936	0.287909

### Canada Goose young abundances by year

Effect	NumDF	DenDF	FValue	ProbF
Year	3	355.7891	0.93016	0.426224
Area	1	12.08153	1.3427	0.26895
Year*Area	3	355.7891	2.325092	0.074576

### Total abundances of birds excluding Canada Goose by season

Effect	NumDF	DenDF	FValue	ProbF
Year	3	957.0893	6.097085	0.000414
Season	3	956.0265	15.10418	1.31E-09
Year*Season	9	955.1764	2.977025	0.001678
Area	1	11.93282	5.344064	0.039465
Year*Area	3	957.0893	1.777352	0.149808
Season*Area	3	956.0265	6.138712	0.00039
Year*Season*Area	9	955.1764	5.396058	3.11E-07

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Seasonal species richness

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1954.017	44.59843	7.12E-28
Season	3	1950.926	54.31848	1.02E-33
Year*Season	9	1948.848	9.6262	1.69E-14
Area	1	13.5318	0.334734	0.572389
Year*Area	3	1954.017	1.126513	0.337003
Season*Area	3	1950.926	6.088501	0.000403
Year*Season*Area	9	1948.848	1.568451	0.119145

#### Wetland user abundances (No CAGO)

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.845	2.501663	0.057751
Season	3	1949.993	26.25459	1.2E-16
Year*Season	9	1947.524	4.694786	3.46E-06
Area	1	10.71849	1.011805	0.336639
Year*Area	3	1953.845	1.629298	0.180565
Season*Area	3	1949.993	14.75269	1.69E-09
Year*Season*Area	9	1947.524	2.825782	0.002644

#### Freshwater marsh user abundances (No CAGO)

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1951.008	6.910458	0.000126
Season	3	1950.448	5.893332	0.000531
Year*Season	9	1948.606	1.10314	0.356933
Area	1	12.33777	0.128086	0.726473
Year*Area	3	1951.008	2.716043	0.043337
Season*Area	3	1950.448	6.715333	0.000166
Year*Season*Area	9	1948.606	0.893387	0.530287

#### Mudflat/Shore user abundances (No CAGO)

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.817	3.406447	0.016977
Season	3	1949.75	46.06403	9.3E-29
Year*Season	9	1947.15	3.96038	5.1E-05
Area	1	10.22204	1.581735	0.236483
Year*Area	3	1953.817	1.292556	0.275303
Season*Area	3	1949.75	10.86565	4.45E-07
Year*Season*Area	9	1947.15	2.164493	0.021861

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### American Green-winged Teal

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1952.748	0.512867	0.673439
Season	3	1950.802	9.205389	4.78E-06
Year*Season	9	1948.971	0.436304	0.91597
Area	1	13.13963	0.659508	0.431201
Year*Area	3	1952.748	0.174106	0.913948
Season*Area	3	1950.802	9.612462	2.67E-06
Year*Season*Area	9	1948.971	0.810881	0.606189

#### American Crow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1924.42	5.232068	0.001346
Season	3	1949.871	11.18934	2.8E-07
Year*Season	9	1948.413	0.532394	0.851862
Area	1	12.42906	2.699676	0.12541
Year*Area	3	1924.42	2.354184	0.070276
Season*Area	3	1949.871	0.60462	0.612005
Year*Season*Area	9	1948.413	1.378083	0.192432

#### American Tree Sparrow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1742.379	0.573981	0.632146
Season	3	1928.222	0.666976	0.572322
Year*Season	9	1920.544	0.677529	0.729952
Area	1	2.400433	0.580088	0.514039
Year*Area	3	1742.379	0.573981	0.632146
Season*Area	3	1928.222	0.666976	0.572322
Year*Season*Area	9	1920.544	0.677529	0.729952

#### Barn Swallow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1918.085	1.979689	0.114994
Season	3	1949.953	19.89273	1.06E-12
Year*Season	9	1948.52	2.804079	0.002842
Area	1	12.76174	0.182781	0.676119
Year*Area	3	1918.085	0.442199	0.722854
Season*Area	3	1949.953	0.681934	0.563067
Year*Season*Area	9	1948.52	1.119985	0.344694

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Black-crowned Night Heron

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1950.198	1.796849	0.145713
Season	3	1950.567	6.283842	0.000306
Year*Season	9	1948.838	0.882875	0.539804
Area	1	12.8124	1.184457	0.296499
Year*Area	3	1950.198	1.796849	0.145713
Season*Area	3	1950.567	6.283842	0.000306
Year*Season*Area	9	1948.838	0.882875	0.539804

#### Bobolink

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1899.977	1.017678	0.38377
Season	3	1950.408	2.114483	0.096411
Year*Season	9	1948.845	1.02872	0.414244
Area	1	13.84637	2.475315	0.138212
Year*Area	3	1899.977	1.017678	0.38377
Season*Area	3	1950.408	2.114483	0.096411
Year*Season*Area	9	1948.845	1.02872	0.414244

#### Cedar Waxwing

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1905.442	1.005399	0.389379
Season	3	1950.448	0.642213	0.587868
Year*Season	9	1948.996	0.693579	0.715331
Area	1	14.11228	0.787442	0.389748
Year*Area	3	1905.442	0.962979	0.409297
Season*Area	3	1950.448	0.616256	0.604467
Year*Season*Area	9	1948.996	0.756448	0.657063

#### Chimney Swift

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1934.264	1.016077	0.384493
Season	3	1950.151	13.20625	1.55E-08
Year*Season	9	1948.717	1.643719	0.097625
Area	1	12.89604	2.820459	0.117119
Year*Area	3	1934.264	0.849274	0.466892
Season*Area	3	1950.151	6.896877	0.000128
Year*Season*Area	9	1948.717	2.561735	0.006284

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Common Grackle

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1937.18	2.660407	0.046701
Season	3	1950.022	5.786462	0.000617
Year*Season	9	1948.5	1.283821	0.240443
Area	1	12.39626	1.379345	0.262282
Year*Area	3	1937.18	2.688975	0.044944
Season*Area	3	1950.022	1.165642	0.321451
Year*Season*Area	9	1948.5	1.101448	0.358178

#### Common Yellowlegs

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1950.385	8.269473	1.82E-05
Season	3	1949.503	45.12468	3.44E-28
Year*Season	9	1947.264	5.477574	1.83E-07
Area	1	10.20198	13.5322	0.004116
Year*Area	3	1950.385	6.979618	0.000114
Season*Area	3	1949.503	41.97227	2.79E-26
Year*Season*Area	9	1947.264	4.867462	1.82E-06

#### Crow Sp.

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1947.422	9.472231	3.27E-06
Season	3	1950.465	20.59007	3.91E-13
Year*Season	9	1948.84	2.287814	0.014966
Area	1	12.87946	0.359271	0.559308
Year*Area	3	1947.422	2.306698	0.074836
Season*Area	3	1950.465	2.45677	0.061313
Year*Season*Area	9	1948.84	7.272179	1.81E-10

#### European Starling

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1945.33	2.45763	0.061244
Season	3	1949.951	13.40634	1.16E-08
Year*Season	9	1948.19	2.082134	0.028026
Area	1	11.65322	6.28598	0.028065
Year*Area	3	1945.33	0.990524	0.396263
Season*Area	3	1949.951	9.670619	2.46E-06
Year*Season*Area	9	1948.19	1.603772	0.108581

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Fish Crow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1926.863	1.028145	0.379039
Season	3	1949.562	9.292889	4.22E-06
Year*Season	9	1947.996	3.025373	0.001352
Area	1	11.62223	6.814606	0.023299
Year*Area	3	1926.863	1.467829	0.221422
Season*Area	3	1949.562	2.486166	0.058958
Year*Season*Area	9	1947.996	1.424083	0.171976

#### Great Black-backed Gull

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1939.257	6.300112	0.000299
Season	3	1939.168	30.98994	1.45E-19
Year*Season	9	1938.281	3.737375	0.000113
Area	1	15.59858	0.534735	0.475465
Year*Area	3	1939.257	5.041382	0.001758
Season*Area	3	1939.168	23.05415	1.16E-14
Year*Season*Area	9	1938.281	3.192813	0.000764

#### Great Blue Heron

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.352	4.572052	0.003388
Season	3	1950.734	2.760705	0.04081
Year*Season	9	1948.778	0.945728	0.483844
Area	1	12.71939	8.203657	0.01354
Year*Area	3	1953.352	2.396949	0.066392
Season*Area	3	1950.734	4.160602	0.006004
Year*Season*Area	9	1948.778	0.839608	0.579496

#### Great Egret

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1950.888	3.011672	0.029073
Season	3	1950.336	41.07574	9.78E-26
Year*Season	9	1948.454	1.267146	0.249826
Area	1	12.0686	3.496616	0.085939
Year*Area	3	1950.888	3.392494	0.017304
Season*Area	3	1950.336	7.858591	3.27E-05
Year*Season*Area	9	1948.454	1.591319	0.112208

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Greater Yellowlegs

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1952.631	1.354234	0.255108
Season	3	1950.739	9.157555	5.12E-06
Year*Season	9	1948.885	1.206235	0.286454
Area	1	12.90429	1.712706	0.213463
Year*Area	3	1952.631	0.858303	0.462088
Season*Area	3	1950.739	3.527105	0.01439
Year*Season*Area	9	1948.885	0.380772	0.944782

#### Herring Gull

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1934.126	2.21744	0.084204
Season	3	1949.636	8.320447	1.69E-05
Year*Season	9	1948.021	0.402357	0.934355
Area	1	11.55625	4.16848	0.064692
Year*Area	3	1934.126	1.943175	0.120585
Season*Area	3	1949.636	2.79264	0.039092
Year*Season*Area	9	1948.021	0.581528	0.813258

#### Hooded Merganser

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1926.083	1.246116	0.291455
Season	3	1949.712	3.134751	0.024597
Year*Season	9	1948.199	1.025795	0.4166
Area	1	11.99383	0.0767	0.786535
Year*Area	3	1926.083	1.415013	0.236543
Season*Area	3	1949.712	0.608371	0.609569
Year*Season*Area	9	1948.199	1.729012	0.077438

#### Killdeer

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1954.073	5.703454	0.000693
Season	3	1951.007	5.12486	0.001564
Year*Season	9	1949.038	0.831081	0.587397
Area	1	13.42901	0.009561	0.923552
Year*Area	3	1954.073	0.538237	0.656116
Season*Area	3	1951.007	2.000383	0.111928
Year*Season*Area	9	1949.038	1.070848	0.381164

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Laughing Gull

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1880.557	0.620719	0.601595
Season	3	1944.166	1.928715	0.12287
Year*Season	9	1941.108	0.946472	0.483199
Area	1	5.937503	0.144723	0.716867
Year*Area	3	1880.557	0.656974	0.57857
Season*Area	3	1944.166	0.949672	0.415714
Year*Season*Area	9	1941.108	0.529582	0.853964

#### Least Sandpiper

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1932.291	2.519564	0.056391
Season	3	1950.043	0.498431	0.683401
Year*Season	9	1948.591	0.385774	0.942455
Area	1	12.64949	0.218285	0.648296
Year*Area	3	1932.291	1.269636	0.283172
Season*Area	3	1950.043	0.328849	0.804506
Year*Season*Area	9	1948.591	0.681344	0.726491

#### Lesser Yellowlegs

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1924.522	4.512657	0.003681
Season	3	1949.418	2.034047	0.107117
Year*Season	9	1947.823	2.887832	0.00215
Area	1	11.38918	2.091977	0.175028
Year*Area	3	1924.522	5.246027	0.00132
Season*Area	3	1949.418	2.579938	0.052016
Year*Season*Area	9	1947.823	2.729485	0.003636

#### Mallard

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1953.752	1.52238	0.206741
Season	3	1950.647	8.817269	8.33E-06
Year*Season	9	1948.568	0.964913	0.467277
Area	1	12.36064	1.792056	0.204777
Year*Area	3	1953.752	1.60965	0.18513
Season*Area	3	1950.647	4.539402	0.003546
Year*Season*Area	9	1948.568	0.685466	0.72274

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Marsh Wren

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1954.123	1.062402	0.363911
Season	3	1951.069	19.99726	9.14E-13
Year*Season	9	1949.06	0.330404	0.965211
Area	1	13.84192	0.115581	0.738981
Year*Area	3	1954.123	5.395593	0.001069
Season*Area	3	1951.069	7.703254	4.08E-05
Year*Season*Area	9	1949.06	4.162498	2.45E-05

#### Northern Pintail

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1907.253	3.05759	0.027322
Season	3	1950.463	4.415547	0.004213
Year*Season	9	1949.043	2.791665	0.002961
Area	1	14.18124	1.727099	0.209643
Year*Area	3	1907.253	4.770751	0.002569
Season*Area	3	1950.463	1.387358	0.244829
Year*Season*Area	9	1949.043	4.7742	2.58E-06

#### Pectoral Sandpiper

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1902.027	0.498837	0.683121
Season	3	1948.784	1.683869	0.168433
Year*Season	9	1946.981	0.879362	0.542998
Area	1	10.44752	0.929264	0.356837
Year*Area	3	1902.027	1.009901	0.387315
Season*Area	3	1948.784	2.267783	0.078788
Year*Season*Area	9	1946.981	0.690533	0.718116

#### Ring-billed Gull

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1952.849	5.233379	0.001343
Season	3	1949.903	60.28302	2.88E-37
Year*Season	9	1947.601	3.886268	6.65E-05
Area	1	10.71516	2.3669	0.152923
Year*Area	3	1952.849	2.067372	0.10255
Season*Area	3	1949.903	12.14155	7.14E-08
Year*Season*Area	9	1947.601	2.320337	0.013525

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Rusty Blackbird

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1899.573	0.890917	0.44508
Season	3	1949.751	0.915068	0.432805
Year*Season	9	1948.103	0.936876	0.491577
Area	1	12.25857	0.829774	0.379902
Year*Area	3	1899.573	0.890917	0.44508
Season*Area	3	1949.751	0.915068	0.432805
Year*Season*Area	9	1948.103	0.936876	0.491577

#### Red-winged Blackbird

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1946.912	2.148768	0.092168
Season	3	1949.769	7.145042	9.02E-05
Year*Season	9	1947.869	1.427259	0.170632
Area	1	11.13864	6.51942	0.026607
Year*Area	3	1946.912	0.45923	0.710804
Season*Area	3	1949.769	5.710583	0.000687
Year*Season*Area	9	1947.869	1.058462	0.390721

#### Semi-palmated Sandpiper

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1945.149	0.616325	0.604422
Season	3	1950.274	2.29032	0.076475
Year*Season	9	1948.652	0.278028	0.980745
Area	1	12.51238	1.809394	0.202455
Year*Area	3	1945.149	0.298613	0.826426
Season*Area	3	1950.274	2.284512	0.077064
Year*Season*Area	9	1948.652	0.226008	0.990875

#### Solitary Sandpiper

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1912.918	2.391164	0.066911
Season	3	1949.337	3.286798	0.019994
Year*Season	9	1947.727	1.126934	0.339727
Area	1	11.39418	0.946668	0.350772
Year*Area	3	1912.918	1.673095	0.170773
Season*Area	3	1949.337	0.914089	0.433297
Year*Season*Area	9	1947.727	1.323188	0.219366

## Appendix 1 (Cont.)

### Repeated Measures ANOVA Tables

#### Song Sparrow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1951.026	17.46477	3.44E-11
Season	3	1948.893	0.595601	0.61789
Year*Season	9	1946.612	3.57052	0.000205
Area	1	12.59299	0.442775	0.517789
Year*Area	3	1951.026	2.200969	0.086049
Season*Area	3	1948.893	0.281913	0.838491
Year*Season*Area	9	1946.612	1.482009	0.148802

#### Swamp Sparrow

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1923.679	8.970034	6.7E-06
Season	3	1948.366	5.345846	0.001147
Year*Season	9	1946.435	1.731709	0.076866
Area	1	9.484487	3.155922	0.10767
Year*Area	3	1923.679	4.1461	0.006127
Season*Area	3	1948.366	0.71713	0.541713
Year*Season*Area	9	1946.435	0.492201	0.880697

#### Wood Duck

Effect	NumDF	DenDF	FValue	ProbF
Year	3	1933.37	0.230241	0.875371
Season	3	1950.07	5.116331	0.001583
Year*Season	9	1948.616	0.382319	0.944068
Area	1	12.67866	4.706181	0.04969
Year*Area	3	1933.37	1.896591	0.1281
Season*Area	3	1950.07	3.133112	0.024652
Year*Season*Area	9	1948.616	0.548082	0.839908